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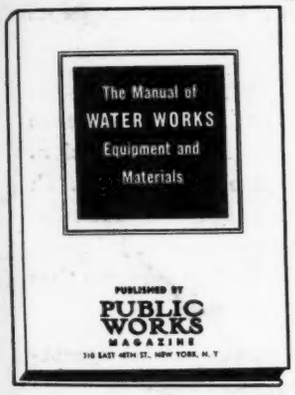

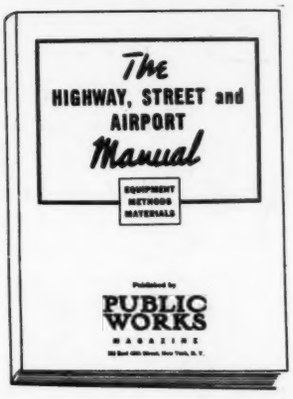

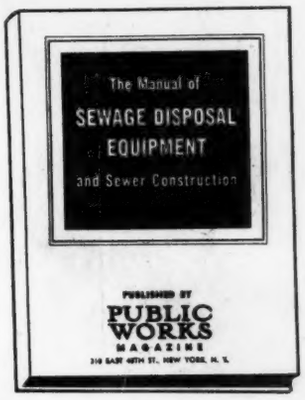

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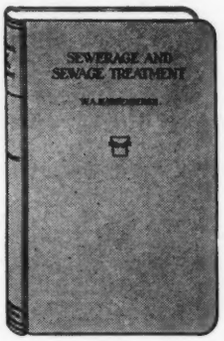

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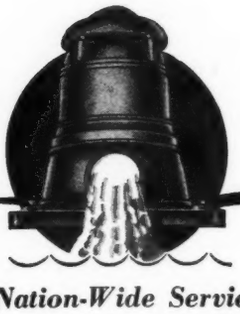

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THE WAR EMERGENCY

Snow Removal in the Emergency

The service of snow removal when performed for any governmental agency—federal, state or local—has been exempted from price control by the Office of Price Administration. Likewise exempted was the rental of snow removal equipment to governmental agencies.

OPA explained that the seasonal nature of snow removal and its emergency character, with the frequent necessity of assembling large amounts of equipment and labor under widely varying conditions to clear vital highways, makes price control of this service impractical at the present time.

Snow removal and the rental of snow removal equipment, when under contract with a private concern, remain under the Services Regulation (No. 165 as amended) which fixes maximum charges at March levels.

The exemption is contained in Amendment No. 12 to Supplementary Regulation No. 11 effective January 7.

Snow removal in Lexington, Mass., is being modified to meet current conditions, according to Superintendent of Public Works William C. Paxton. The loss of men and equipment probably will require completion of street plowing before the snow can be removed from the business areas. Plowing of sidewalks will follow, and finally, sanding operations will be performed where necessary. Normally, states Mr. Paxton, these operations are carried out at the same time with expanded crews, and plentiful equipment, some of which has been rented in the past but no longer will be available.

Sewer Maintenance in Bombed Areas

Maintenance of sewer service in bombed areas has been one of the major difficulties confronting municipal authorities in cities under enemy attack. To assist American municipal officials and defense councils in planning for emergencies and for the restoration of normal service following damage resulting from enemy action, the sanitary engineering section of the Medical Division of the Office of Civilian Defense has issued its second sanitary engineering bulletin, "Municipal Sanitation under War Conditions."

WPB Cancels 89 Construction Projects

The Director General for Operations of the War Production Board issued three orders on December 14 cancelling 89 construction projects which included 42 highway jobs. In addition to highways, the projects cancelled include schools and other public buildings, water works, reclamation projects and miscellaneous utility work.

The WPB order not only revokes the preference rating issued in connection with these projects but specifically directs that the construction thereof be stopped immediately. Some of the projects cancelled had not been started while others were rather hopelessly bogged down due to material shortages.

Although there are no official figures it is nevertheless understood that many additional highway projects are likewise slated for cancellation. In some quarters it is estimated that within the near future approximately 200 highway projects will be terminated by action of the War Production Board.

Planning Post-War Public Works

Public works, planned in advance to the last engineering detail so that construction can start immediately when needed, are characterized by Maj. Gen. Philip B. Fleming, Federal Works Administrator, as "perhaps the most useful of all projects" to take up the employment slack during the national conversion from a wartime to a peacetime basis.

With financing arrangements completed and blue prints and and specifications perfected, the building of public works could begin in the shortest possible time after the war and provide, directly and indirectly, jobs for the greatest possible number of people.

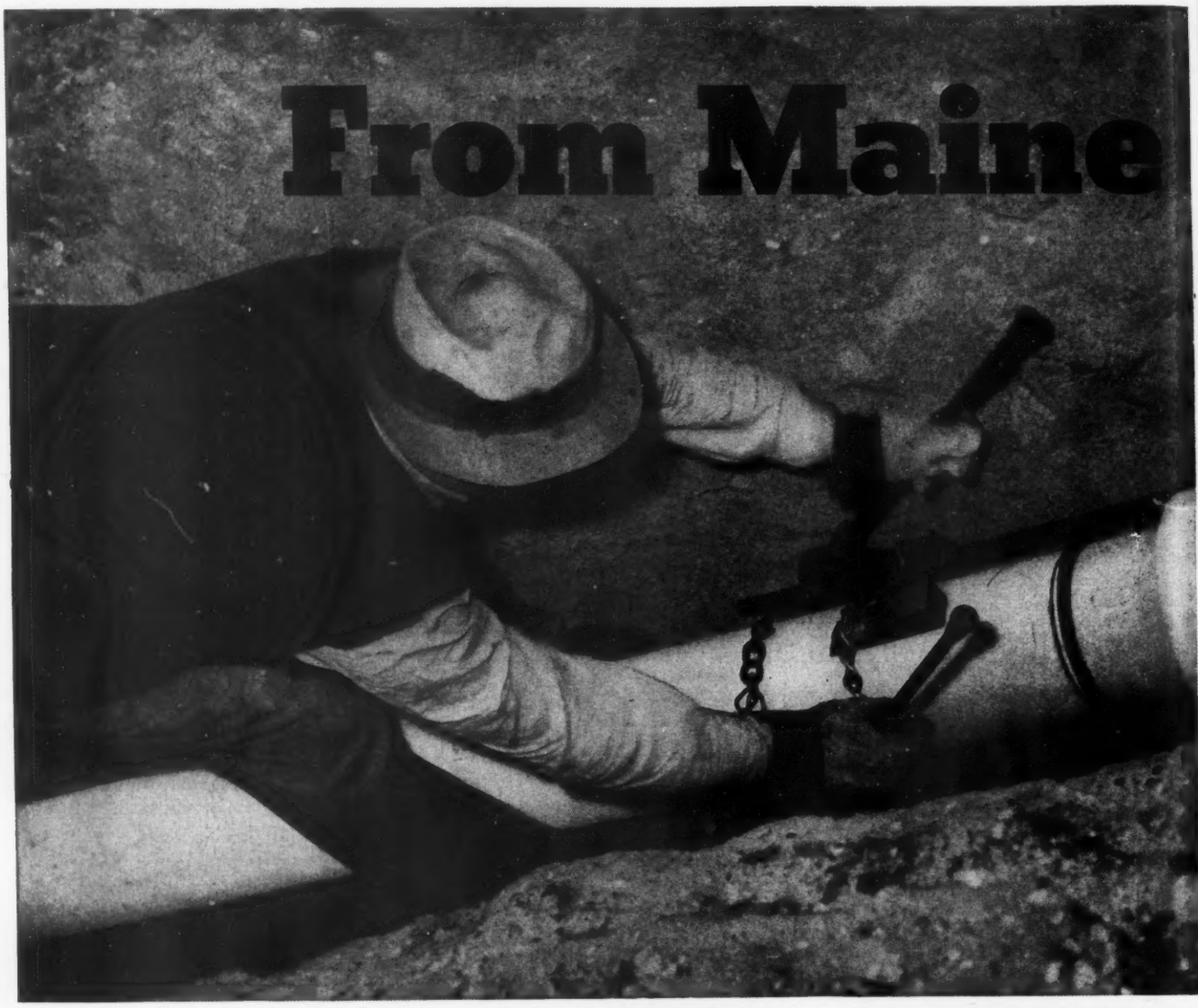
"As I see it," he said, "the type of planning for public works which we now need is one in which the preliminaries will be gotten out of the way before the war ends: the site will be acquired, the legal conditions will be met, the plans for financing will be made, the blueprints will be drawn and the specifications written. And then, in the hour of need, we can pull the blueprints out of the cupboard, hand them to the contractor, lead him out to the site and say, 'You begin digging at 7 o'clock tomorrow morning.'

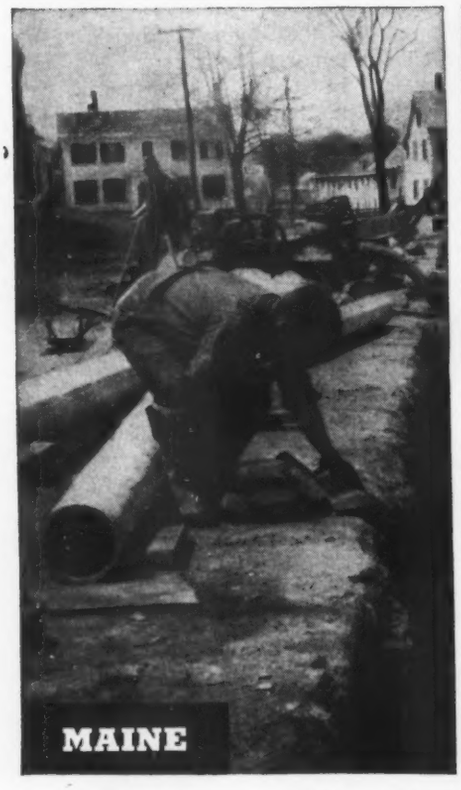
"Thus, each project can be started at a time when the jobs it will create are most needed, and when it can best be financed. Projects can be speeded up or slowed down as the necessities of the employment situation dictate. It is in such over-all nation-wide planning for post-war public works that I hope the Federal Works Agency may be permitted to participate."

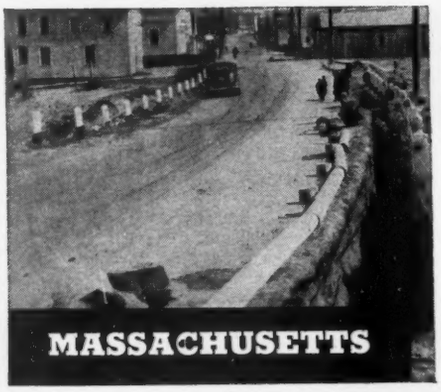
Purchase of Laboratory Equipment

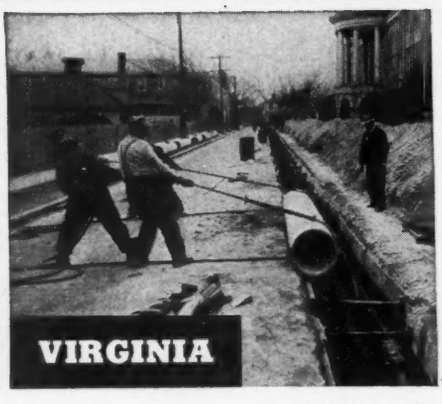
WPB has issued an order placing additional control over laboratory equipment. This order provides that no purchaser of laboratory equipment shall be permitted to acquire an item valued at more than $50 or any quantity of the same item to the value of more than $50, without securing an authorization for such purchase from the Director General for Operations. Application should be made on Form PD-620. Purchases authorized on the basis of this form will be assigned an AA-4 rating.

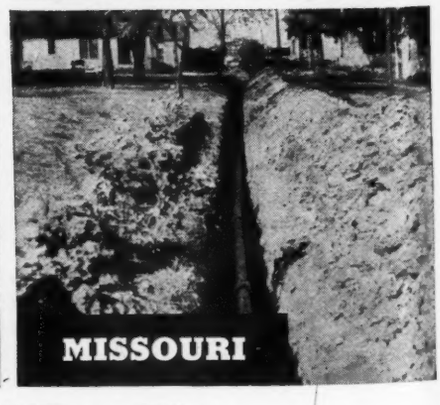
"Laboratory equipment" is defined in the order to mean material, instruments, appliances, devices, parts thereof, tools and operating supplies for laboratories, or for use in connection with operations usually carried on in laboratories, not including second-hand items.











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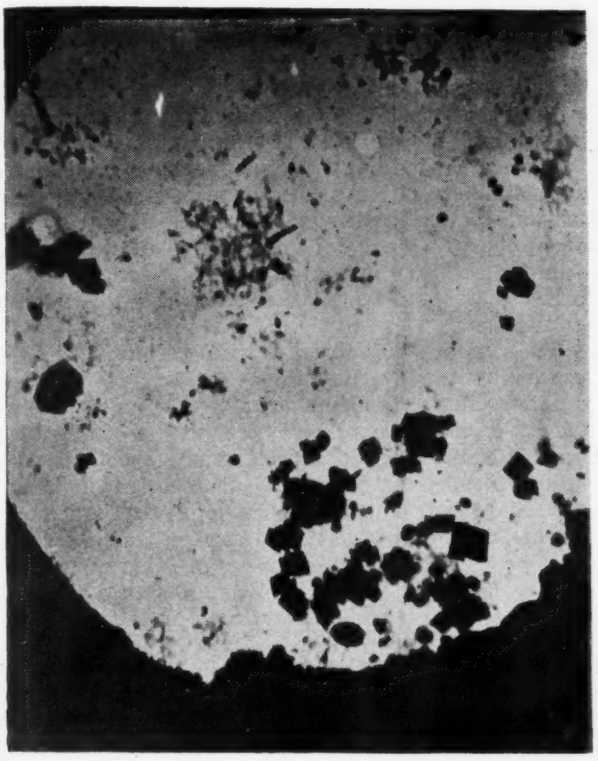


Figs. 1 and 2—Electro-micrographs of Franklin hydrated lime. Enlarged about 13,000 diameters; reduced from photographs of 31,000. These are believed to be the first electro-micrographs dealing with hydrated lime ever published.

Hydrated Lime in Sewage Treatment

Some of the properties of hydrated limes and their effects on sewage clarification and coagulant demand.

By WILLEM RUDOLFS and WM. A. MOGGIO

New Jersey Agricultural Experiment Station, New Brunswick, N. J.

THE use of hydrated lime in modern chemical treatment of sewage is mostly in conjunction with one or several coagulants such as iron or aluminum salts. It serves to reduce the quantities of more expensive chemicals required, thereby lowering the cost of treatment. Its functions are considered to be mainly to neutralize acidity, to adjust the pH values of sewage to the optimum range for coagulation, and to act as a coagulating chemical. There are several other "minor" functions which are of considerable importance at different times.

For comparative studies, different commercial high-calcium hydrated limes were used, selected on the basis of types of limestone deposits and method of preparation. These were limited to four types, namely (a) Franklin or "white limestone," (b) Trenton-Beckmantown (York), (c) Farnam, and (d) Trenton limestone (Bellefonte); all showing approximately the same chemical analyses.

Some Properties of Hydrated Limes

1. *Structure.* Examination under the microscope showed the various hydrated limes to be generally amorphous, although under crossed Nicols a small

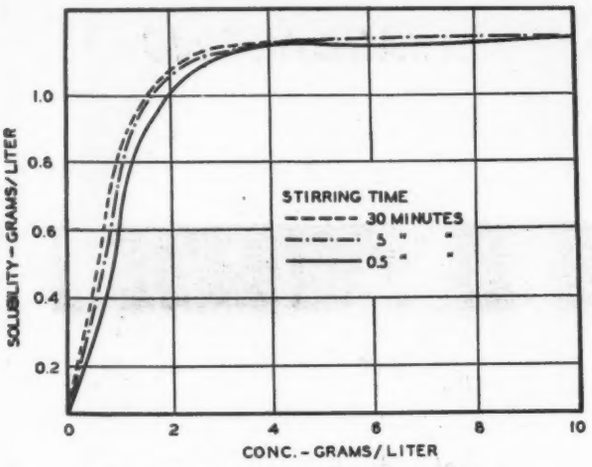


Fig. 3—Effect of time of stirring on solubility.

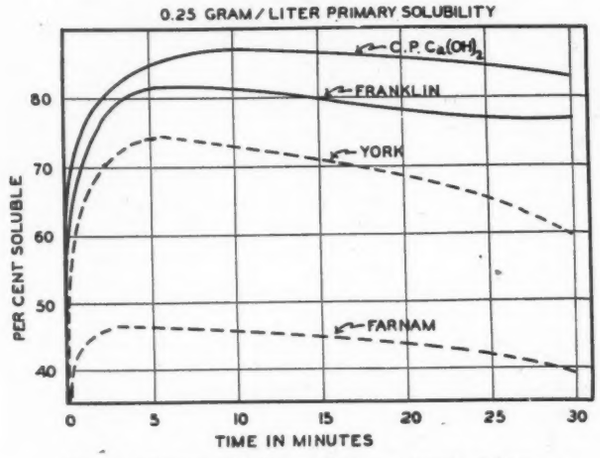


Fig. 4—Primary solubility of different types of lime.

number of particles showed double refraction, indicating the presence of a crystalline structure. One of the hydrated limes (Franklin) appeared to have more particles of a crystalline nature than the other limes examined. Electro-micrographs produced by R. C. A. of Franklin hydrated lime (figs. 1 and 2) appear to show at least a portion of the particles to be present in crystalline form. Measurements of the particles photographed appear to range from 0.032 micron to 0.54 micron actual size. The majority of the non-crystalline particles range from 0.064 micron to 0.096 micron actual size, and the majority of the crystalline particles range from 0.13 micron to 0.25 micron actual size. It seems that particles less than 0.13 micron are either non-crystalline or that the 31,000 magnification was still insufficient to show the structure. The range of the particle sizes shown in the micrographs were materially lower than could be obtained by various sedimentation methods.

2. *Solubility*. The solubility of hydrated lime has a relation to rate and degree of neutralization of acidic compounds present in sewage and affects the resulting pH values.

The solubilities of various commercial limes were determined by using varying amounts of each lime and by changing the times of stirring but keeping constant the speed of stirring as well as the amount of CO_2-free water added. Determinations were then made on the hydrated limes to find the effect of neutralization of the $Ca(OH)_2$ in solution on the secondary solubility of the lime in suspension. Sufficient amounts of lime were added to give approximately three times the saturation value of a given amount of water and stirred at constant speed for 5 minutes. The lime in solution was neutralized with H_2SO_4 and the process repeated for the determination of the "secondary" and "tertiary" solubility.

The solubility of the hydrated limes increases with the time of stirring, reaching its maximum after about 5 minutes with all types of hydrated limes used. The effect of time of stirring on the solubility of various concentrations of lime is illustrated in fig. 3. The primary solubility of different types of lime in concentrations up to 1.2 grams per liter varies considerably. This is illustrated in fig. 4, where different limes of a given concentration are compared for different times of stirring. It is clear that the maximum solubility is reached after about 5 minutes' stirring The secondary solubility reaches its maximum in 5 to 10 minutes, but the total solubility varies again with the types of lime used (fig. 5). Neutralization of the lime in solution and determination of the "tertiary" solubility show again the same relationships and relative solubilities.

The rate of solubility appears to be affected by the concentration of the lime in suspension, but varies for different limes. Comparison of results indicates that the lower the primary and secondary solubility, the greater is the effect of concentration. The total solubility of different limes and their behavior in increased concentrations may be important factors in the use of lime for water and sewage treatment.

3. *pH Adjustment*. Differences in primary and secondary solubility of the hydrated limes may be a factor in the known ability of various limes to raise the pH values to different degrees and at different rates. Experiments showed that there was a marked difference in the neutralization of bicarbonates. As an example, the effects of various hydrated limes on the pH value of raw water (pH 6.89), using 5 p.p.m. lime as CaO, are shown in Table I. The example shows that Franklin lime reached a higher pH value in a shorter time than the other types of lime.

Table I—Measurements of pH Values at Intervals of Time

Stirring Minutes	*Franklin*	*York*	*Farnam*	*Bellefonte*
5	9.11	9.09	9.00	8.81
15	*9.18*	9.11	9.02	8.86
30	9.18	*9.18*	9.08	8.93
45	9.18	9.18	*9.11*	9.00
60	9.18	9.18	9.11	*9.05*

Applications

1. *Effect of Particle Size on Sewage Clarification.* The materials used were the lime fractions obtained by the wet and dry method of separation. The fractions +100; −100, +200; −200, +325, −400 mesh were used in conjunction with various amounts of $FeCl_3$. A few results indicating the effect of the particle size upon the clarification of fresh and stale sewages are given in Table II. With smaller particle sizes of hydrated lime, the clarification of fresh sewage increased materially, but the effect of smaller particles of lime was much less when stale sewages were used. Application of dry separated particles of lime increased the clarification of sewage.

2. *Effect of Quantity and Time on pH of Sewage.* Various sewages treated with increasing quantities of hydrated lime and stirred for different lengths of time responded differently to changes in pH values. In general, the pH values of all sewages became higher with increased quantities of lime, but the character of the sewage appeared to play a role. The variation in

pH values with different hydrated limes for a given sewage is illustrated in fig. 6, together with the effect of time of stirring. With an increase in stirring time from 5 to 30 minutes, the differences in pH values attained were reduced. In general, the shorter the stirring time and the smaller the quantity of lime used the greater were the differences in pH values resulting from the various hydrated limes used.

3. *Effect of Lime Concentration on Turbidity Remaining.* Additions of hydrated lime to distilled water results in turbidity, which increases with increasing quantities of lime. This is not the case when the same quantities of hydrated lime are added to sewage, no matter whether the suspensions are settled for a short time or for several hours. Lime is removed from suspensions in the presence of sewage, even with very large quantities of hydrated lime. The removal is related primarily to certain constituents of sewage. Marked differences in the amounts of suspended hydrated lime occur with larger concentrations of the different limes. These differences in greater concentrations have a distinct bearing upon the manner in which hydrated lime is added to sewage.

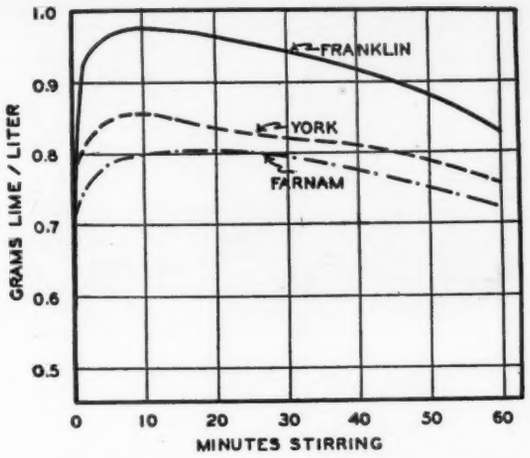


Fig. 5—Total solubility of different types of lime.

Table II—Effect of Particle Size of Lime on Sewage Clarification, Expressed in ppm. Turbidity Remaining After Treatment.

Particle Size	*Fresh Sewage**				*Stale Sewage†*			
	CaO: 100 ppm Fe: 10 ppm		*CaO: 200 ppm Fe: 5 ppm*		*CaO: 100 ppm Fe: 10 ppm*		*CaO: 200 ppm Fe: 5 ppm*	
Sewage	*P*	*S*	*P*	*S*	*1*	*2*	*1*	*2*
± 100	34	43	31	22	57	38	98	36
± 200	18	32	29	18	59	33	98	27
± 325	16	14	23	17	61	25	98	23
— 400	13	13	22	14	59	29	100	20
Dry ± 325	11	12	17	12	43	17	45	14
Dry — 400	9	10	14	9	22	12	35	9

*$FeCl_3$ coagulant demand 20 ppm as Fe.
†$FeCl_3$ coagulant demand 25 ppm as Fe.

4. *Effect of Lime Concentration on Sewage Clarification.* The effect of lime varies with the type and quantity of lime added and the character of sewage treated. The effect of various limes on weak and strong sewages was studied. Addition of lime up 150 to 200 p.p.m. has little effect upon the removal of turbidity of weak sewage, but when a given dosage is reached a sudden sharp reduction in turbidity occurs. With strong sewages the quantity of lime required varied from 200 to 250 p.p.m. to produce similar results. Sewage with laundry waste required 300-350 p.p.m., and strong stale sewage from 400 to 450 p.p.m. hydrated lime as CaO. The lime concentration required not only varies with the character of the sewage but also differs with the type of lime. One hydrated lime may require from 10 to 20 per cent more than another hydrated lime to reach the same degree of turbidity removal.

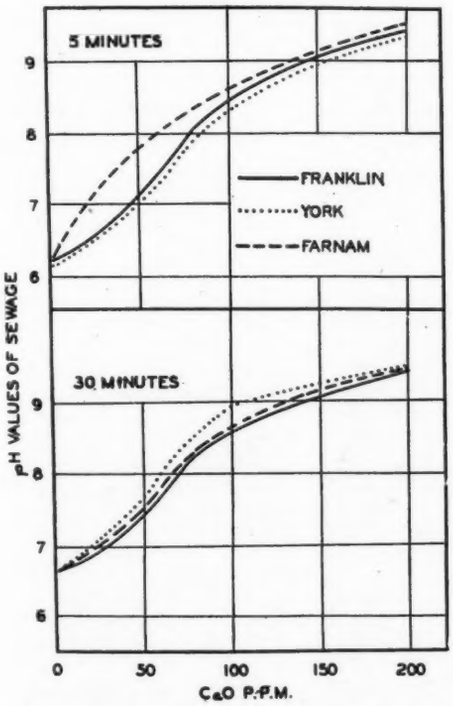


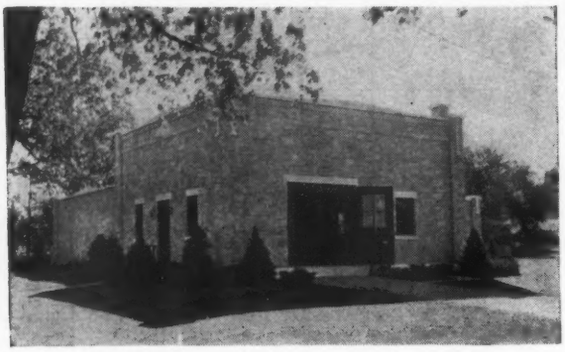
Fig. 6—Variation in pH values with different limes.

5. *Effect of Lime on Coagulant Demand of Sewage.* It is frequently assumed that hydrated lime acts only as a pH adjusting agent in sewage when used in reasonably small quantities in conjunction with iron and aluminum coagulants. This view is apparently erroneous. The various types of lime appear to behave similarly in respect to lowering the coagulant demand of sewage. This is illustrated by a few results given in Table III. A minimum quantity of lime

(Continued on page 45)

Table III—Effect of Hydrated Limes on Coagulant Demand of Sewage (Turbidity Remaining After 1 Hour Settling)

Fe added	*CaO added*	*Franklin*	*York*	*Farnam*	*Bellefonte*
ppm	ppm	ppm	ppm	ppm	ppm
5	150	11	9	12	11
5	200	10	7	8	7
10	50	12	11	10	11
10	100	9	8	8	13



Unit well No. 6, a typical pump house and clear well.

Thirty Years' Experience

By L. A. SMITH
Superintendent of Water Department, Madison, Wis.

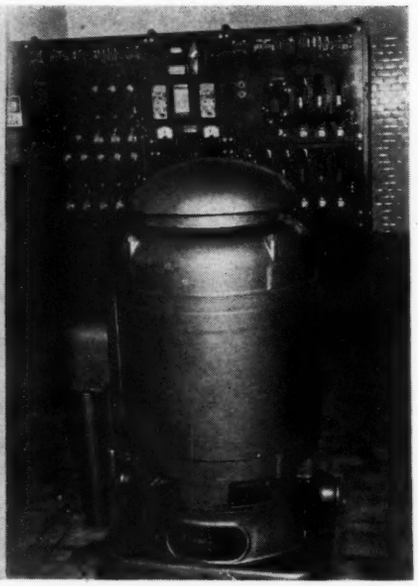
DURING the last thirty years, the development in methods of pumping deep wells has been almost spectacular, as Madison's experience has demonstrated. Since the construction of its original plant in 1881, the City of Madison, Wisconsin, has obtained its water supply from deep wells. For twenty-five years the static water level in the original wells was so close to the surface that these wells could be pumped by direct suction. By 1906, the continuous use of the wells had reduced the operating water level below the safe limits of direct suction and deep well pumps were installed on two wells. These were of the old Wood impeller type used for irrigation work in California. They were very inefficient because they consisted of screw impellers in the eduction pipe, set alternately between vertical vanes to straighten out the water between the impellers. The modern type bearings had not been developed and considerable difficulty was experienced with the ball bearing type which was installed. The problem was partially solved locally by the use of a hydraulic bearing which consisted of two plates between which water was forced under sufficient pressure to more than compensate for leakage, with the result that the plates were held apart.

In 1910, it was necessary to drill two additional wells, which were equipped with the conventional type of turbine deep-well pumps. However, this type of turbine was unsatisfactory because of lubrication difficulties. In fact, when I first came with the Department in 1912, we had a crew of five men working continuously on the four deep well pumps and were satisfied if the repair on the one was done before another went out.

In 1914, because of this difficulty, it was decided to try airlift pumping equipment. The four wells located on the pumping station grounds were equipped with airlift, the air being furnished by two electrically driven air compressors installed in the pumping station. These four wells had been pumped by direct suction and were yielding approximately 175 gpm, but the use of airlift increased their capacity to 1800 gpm, or over ten times as much. It seemed as though airlift was the solution to the local water supply problem and in 1919 five additional wells, located at distances from 500 ft. to 3000 ft. away from the pumping station, were equipped with airlift. The electrically-driven air compressors were removed and new steam-driven air compressors were installed, air being transmitted to the various unit wells by underground pipe lines. Four of these five wells so equipped were those which had had the mechanical deep-well pumps and the fifth one was one which had been pumped by direct suction.

In 1922, the interference between wells located so close together indicated the advisability of drilling additional wells far enough away to prevent this. Therefore, the next well was drilled about two-and-a-half miles from the pumping station and was equipped with a motor-driven deep-well turbine pump, pumping directly into the mains. This was known as Unit Well No. 1. Subsequently, six more unit wells were drilled, some of them being equipped with turbine pumps and the others with airlift, horizontal centrifugal pumps discharging directly into the mains. All of them were self-contained pumping stations.

Foot piece used in airlift pumps.



Interior of unit well No. 6, where deep-well turbine is used.

The matter of determining whether airlift or turbine pumps should be used in developing a deep-well supply depends upon several factors. Airlift has the following advantages:

1. If the well happens to be a sand producer, turbine pumps are difficult to maintain, but an airlift pump will give satisfactory service for many years.

2. There are no moving parts in the well so that the reliability of airlift pumping equipment is very high.

3. If the water from the well contains iron, a considerable portion can be precipitated in a clear well at the surface of the ground if airlift pumping is used, because the close contact between the air and water tends to cause the iron to precipitate.

4. The use of airlift permits the development of a well to its maximum capacity because of the tre-

Deep Well Pumping Equipment

Beginning with old impeller pumps, Madison has progressed through airlift and turbines of increasing efficiencies and modern submersible units, with cost falling more than fifty per cent.

mendous velocity of the mixture of air and water in the eduction pipe.

The advantages of the present turbine deep-well pumps may be briefly summarized as follows:

1. Modern design, together with many years' experience, has enabled manufacturers to produce very reliable pumps.
2. They are more efficient than airlift.
3. They lend themselves to automatic operation, because a motor-driven deep-well turbine can be operated automatically better than a motor-driven air compressor because—to date, at least—no rotary-type air compressor has been developed in the capacity ordinarily required for deep-well pumping.
4. The lower horsepower required reduces the electrical demand charge.

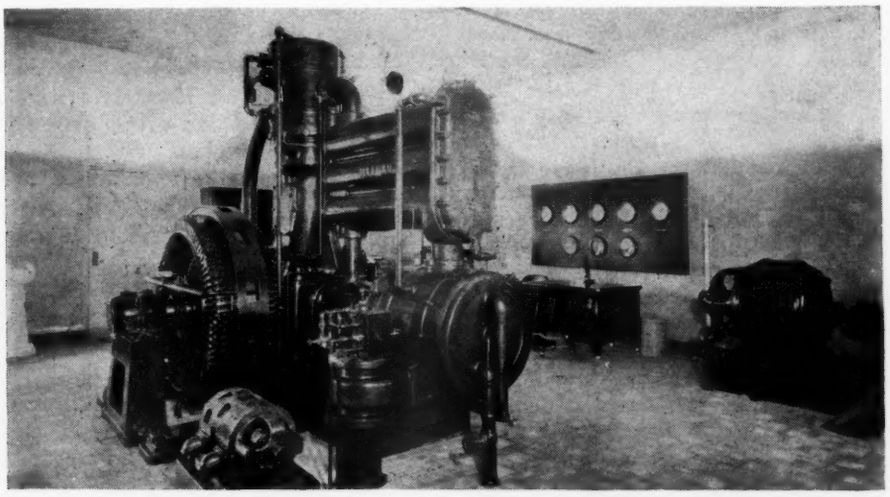
In 1932 it was deemed advisable to increase the capacity of the wells in the Station group and a new well was drilled on the Station grounds, replacing the four original wells. The new well had an outer casing 30″ in diameter and an inner casing of 24″, with a 22″ hole in the rock, the total depth being about 750′. The four old wells which were replaced were small in size, the largest having a diameter of 8″. When the new well was tested, it was found that it had a capacity of over 3000 gpm but that it produced considerable sand and some iron. It was therefore equipped with airlift. This well gave such satisfactory service that in 1937 a second modern type well was drilled, replacing two old wells located at a distance of approximately 3000 ft. from the pumping station. This was known as the East Well and was equipped with airlift because there was an adequate air line available and ample compressor capacity at the main station. In all cases, the abandoned wells were plugged at the bottom of the casing and the casing filled with cement grout.

In connection with this improvement, a suction reservoir was built at the site of the East Well with a capacity of 650,000 gallons. The elevation of the water in this clear well, under operating conditions, is approximately 30″ above the operating level in the station ground, to partially compensate for friction loss. The operation of this unit was never very satisfactory because the efficiency was extremely low, due to the friction loss in the airline, and the well could not economically be developed to the proper capacity. Consideration was given to the use of a deep-well turbine at the East Well, but this would have involved the construction of a well-house on top of the suction reservoir, since the well was drilled in the corner of the reservoir.

About five years ago, the Byron Jackson submersible pumping unit was announced, consisting of a pump and motor located in the well at the proper elevation, the only connection between the unit and the surface of the ground being the discharge pipe and a pair of wires to transmit the electrical energy to the submerged motor. While the effiicency of the submersible unit is not quite so high as that of the conventional type deep-well pump, the power loss in the transmission of electrical energy is less than the loss of energy through the conventional line shaft and bearing, so that the over-all efficiency compares favorably.

One of the Unit Wells, located three miles south

L. A. Smith.



Interior of Unit Well No. 4, where airlift pumping is used. The horizontal centrifugal pump, which pumps into the mains, is shown at the right.

Submersible unit being installed in east well.

of the city, had originally been equipped with a motor-driven deep-well pump, pumping directly into the mains. Several years ago, a clear well was built at the site of this well and a new turbine pump of greater capacity was installed, pumping into the clear well, from which it was pumped into the distribution system by a motor-driven horizontal centrifugal pump.

When the new turbine pump was installed, it had to be placed at a lower point in the well and it was discovered that the hole itself was crooked. This made it almost impossible to maintain the line and shafting because the flexing in the shaft gave trouble continuously. It appeared that the submersible type unit might be a solution to this problem because a crooked hole would not adversely affect transmission of power through a pair of wires. About three years ago, a submersible unit was installed and after a year or so of operation, in which the unit proved entirely satisfactory, consideration was given to replacing the airlift pumping equipment at the East Well in order to reduce the operating cost.

While the East Well is within 3000 feet of the Main Station well, the interference is not serious, but develops in a rather peculiar way. The Main Station well, which has a capacity of approximately 3000 gpm, and the East Well, which has a capacity of 1600 gpm, can be pumped together continuously for six days without noticeable interference. However, on the seventh day the effect of interference becomes apparent and the total supply from the two wells drops from 4500 gpm to less than 4000 gpm. In fact, quite often by the seventh day the water in the East Well has receded to a point where the airlift pump stopped operating. The demand for water upon a water utility is always at its minimum on Sundays because of the decrease of commercial and industrial operation and is always at its maximum on Monday, which is washday. This fact was taken advantage of by shutting down the East Well every Saturday night, thus eliminating interference and permitting the water level in the ground to rise. On Monday when the demand for water was the greatest, the East Well was started and the amount of water for the first two or three hours was even greater than normal while the static head was being pumped off.

In September, 1941, a new submersible deep-well pump and motor was ordered, together with the necessary switchboard and automatic controlling devices. The new equipment arrived early in 1942 and was installed and in operating condition in the early Spring of this year.

The cost of pumping this well by airlift was $12.50 per million gallons, whereas the cost with the submersible unit has been $6.08 per million gallons, a saving of over 50%. While it is probable that the maintenance cost of the submersible will be greater than that of an airlift pump, it seems certain that the saving in operating cost will compensate for this several times over.

It may be of interest to note tnat in 1912 an average of approximately 2,000,000 gpd was being furnished with nine wells, whereas at the present time, over 10,000,000 gpd is being furnished with ten wells. The original nine wells in use thirty years ago have all been abandoned.

The over-all cost of pumping at that time was $50 per million gallons, while it is less than $30 per million gallons at the present time. This decrease has occurred in spite of the fact that wages have more than doubled and the cost of materials and supplies used in operation has materially increased. In fact, the present water rates in Madison are less than they were thirty years ago, but there is an operating profit of approximately $125,000 per year at the present time, whereas there was an operating deficit of about $20,000 in 1912. This means that the increased operating efficiencies of the modern pumping equipment, together with the increased demand at the present time, have more than absorbed the increase in operating costs.

Maintenance of Pumps

Some suggestions for maintaining pumping plants were offered by J. P. Cooper, master mechanic at the Clark Thread Company's plant at Clarkdale, Georgia, in a paper before the Eleventh Annual Georgia Water and Sewage School. These suggestions, greatly condensed, were as follows:

There is a usual tendency among many of us to over oil or grease pump and motor bearings. In one plant 156 motors were out of service due to faulty bearings caused by over greasing.

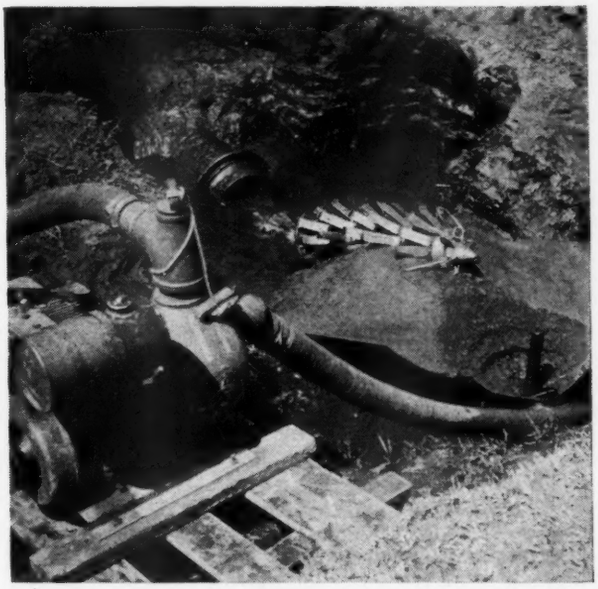
When a bearing is cleaned and greased, the drain plug should be removed and the shaft rotated about thirty minutes to throw off excess lubricant before the plug is replaced.

Overhead bearings may be cleaned by compressed air and repacked.

Fast operating bearings need less lubricant than slow ones. All operating equipment should be shut down during the cleaning and lubricating period. This will insure a more thorough job and less accidents.

Worn bearing shafts may be repaired by metalizing, i.e., hot metal is applied by stationary spray gun to slowly rotating defective area.

Deposit removed from one bad run of pipe.



Tool coming out of pipe (upper center) and gasoline pump ready to pump out the hole so the main can be closed.

Cleaning Mains in a Small City

By M. C. TURNER
Superintendent Water Dept., Conway, Ark.

A city of six thousand population has its entire twenty-three miles of pipe cleaned, with 33 1/3 per cent increase in flow, better pressure and lower insurance rates.

CONWAY, ARK., has a residence population of about 6,000, and there are about 1200 boarding students in its three colleges. The city owns its own water and electric light plants and sewerage system, which are operated by a non-profit corporation appointed by the city council.

The treatment, as modernized in 1939, comprises application of alum and lime, sedimentation in baffled basins, filtration through rapid sand filters, and disinfection with chlorine gas. The storage reservoir has a capacity of 475,000 gallons. The plant has a rated capacity of one million gallons a day. Its output is about 500,000 gallons.

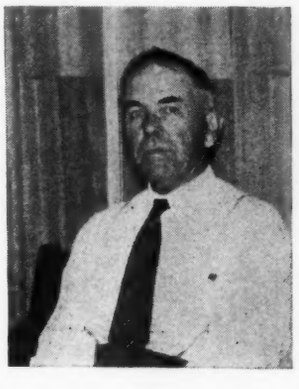
The water plant was installed in 1911, using wood pipes which, in the course of ten or twelve years, were replaced with cast iron. The water comes from Cadron creek, about six miles from town, is passed through filters about a mile from the intake, and flows from them to town by gravity. After about 15 years of use of the iron pipes, their capacity decreased, which was found to be due to tuberculation. The 12″ main from the filter plant to town was cleaned and such a marked increase in flow resulted that arrangements were made in 1941 with the Carver Pipe Cleaning Co. of Walters, Okla., to clean the entire 23 miles of pipe.

The customary "go-devil" was used, forced ahead by the water pressure behind it in most cases. But the pressure in the 4″ pipe was not sufficient for this, and a small flexible rod was pushed through first, a cleaning tool attached to it and pulled through by means of a truck. The 10″ distribution pipes were cleaned first, then the 8″, 6″ and 4″ in that order.

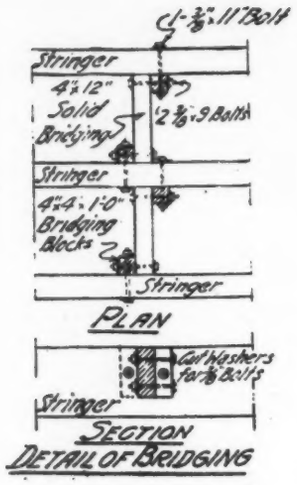
The 4500 ft. of 10″ pumping main from the creek to the filter plant on the hill was cleaned down hill, and as there was no pressure from above, this was furnished by a fire pumper. The same plan for obtaining pressure was followed in cleaning the 2200 ft. of 10″ pipe from filter to clear well.

After the cleaning had been completed the flow in the line from filter plant to clear well was found to have increased 33 1/3%, and tests of fire hydrants in town showed an increased flow of at least 30%.

The result has been a decrease in insurance rates, better pressure and clearer water at all times.



M. C. Turner, Superintendent of the Conway Water Department.



Wyoming standard.

Designing and Constructeos

By W. D. KEENEY
Engineer, Service Bureau, American Wood-Preservers' Association
Chicago, Ill.

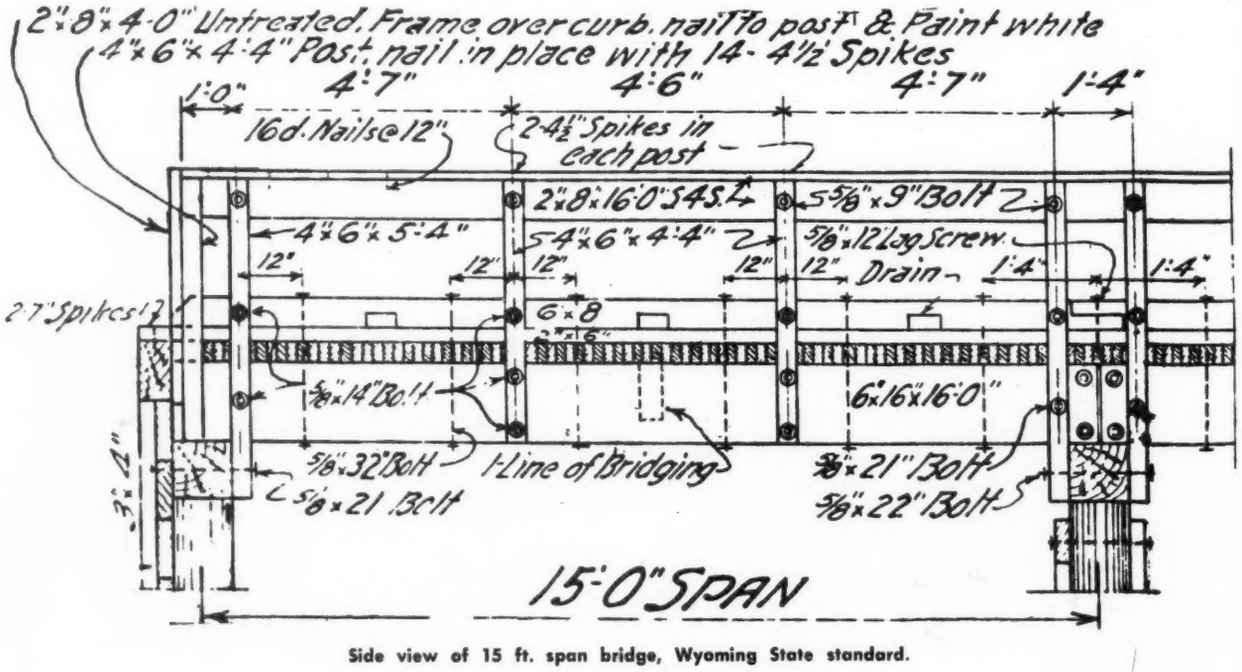
EARLY realization that maximum conservation was necessary to secure an adequate and uninterrupted supply of metals for the armament program naturally brought into bolder relief structures that could be built largely with non-metallic materials, some keeping at a minimum even the small amount of metal ordinarily required for hardware items. The creosoted timber bridge or culvert provided a ready alternate in the earlier days of priorities, before timber, too, took its place among the critical materials. Even today, timber, although subject to priorities, can generally be obtained for warranted structures much more easily than steel; and its use does not impede the production of indispensable armament items as would the diversion of comparable quantities of metal. Moreover, modified designs, utilizing favorable structural characteristics of timber, and a better understanding of timber working stresses have made practicable the use of lower grades of lumber than were commonly demanded in the days of plenty. Properly treated with an effective preservative, these lower grades of lumber have the durability necessary for economical structures that can be maintained at low costs per year of service.

Creosoted timber trestles have been used extensively by railways for many years, and many of them are in good condition today in the fifth and even sixth decade of service. Only in the last two decades have such trestles been used extensively on highways, but that period has been sufficient to assure a service record comparable with that obtained by the railways. It has been sufficient also to permit the accumulation of valuable data on designs tested by actual experience.

In normal times, highway bridges, correctly detailed and built of properly treated timber, with roadway widths suitable for 2-lane traffic, cost from $35 to $50 per lineal foot. While material and labor costs are higher than a year or so ago, the per-lineal-foot costs have not risen excessively and are still considerably below those of other long-lived structures.

Structural Design

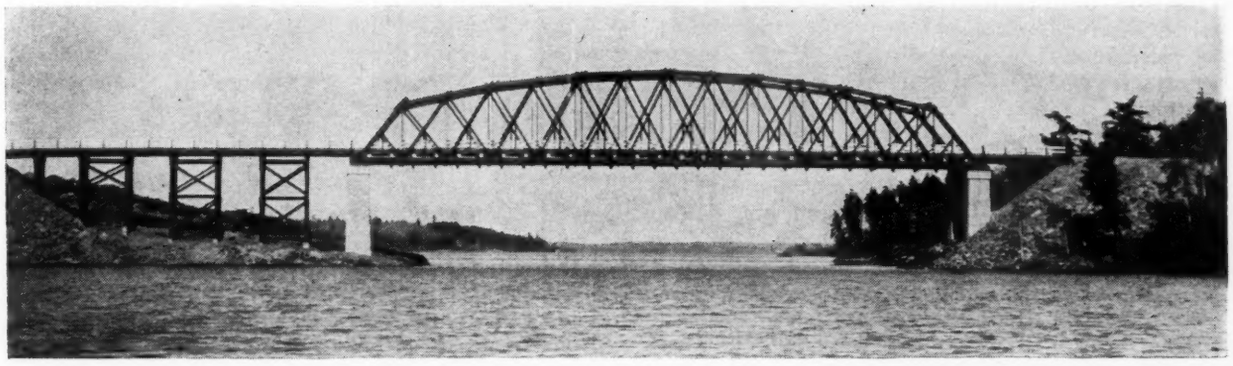
Emphasis must be placed on the importance of correct design and careful attention to details. Each material of construction, whether it be timber, steel or concrete, has characteristics peculiar to it alone which must be recognized and utilized to the best advantage if satisfactory results are to be obtained.



Side view of 15 ft. span bridge, Wyoming State standard.

Creosoted Timber Bridges and Culverts

Detailed information concerning how timber can be and is being used for structures up to 200 ft. span and over. Trestles, trusses and decks, both plain and composite. Preframing and construction.



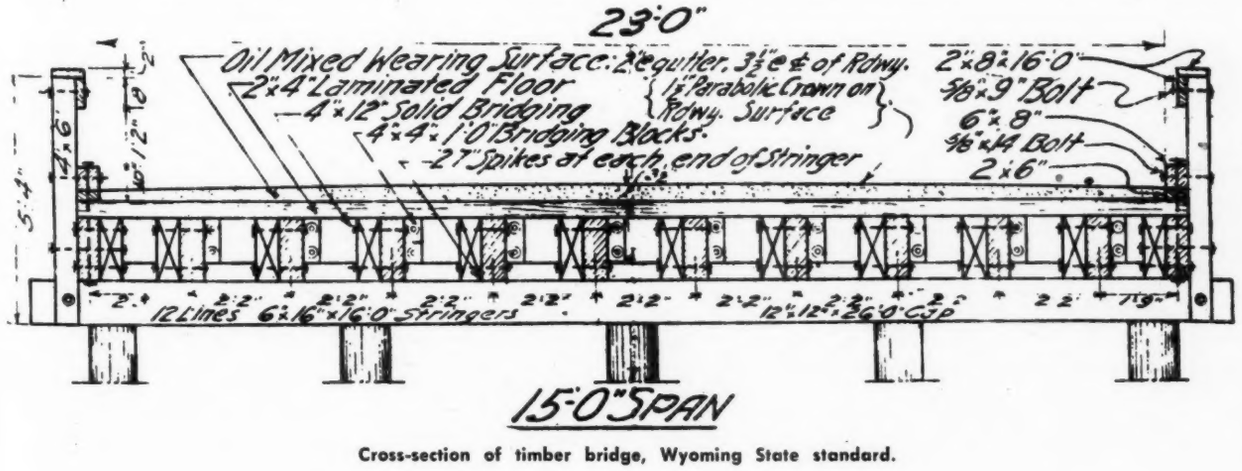
Sioux Narrows, Ontario, timber truss bridge, 210 ft. clear span. Timber creosoted and Teco joint connectors used.

Emphasis should also be placed on the fact that treated timber and untreated timber must be regarded as two distinct materials of construction and that designs developed for untreated timber may not be applicable to treated timber—in fact, in most cases they are not applicable.

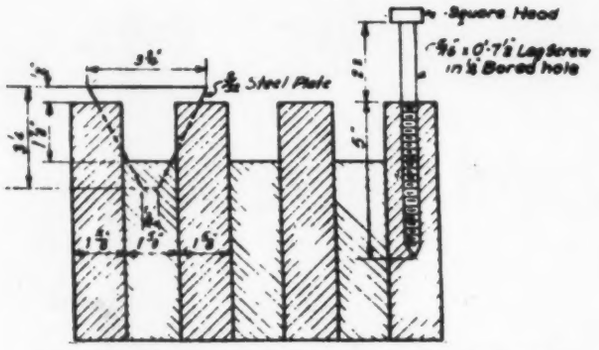
Treated timber trestles with individual span lengths up to about 30 ft. have naturally received somewhat greater attention than other types of timber bridges, since spans of such length, or a series of them, are economically and physically fitted to the majority of stream crossings on any highway system. A survey of some years ago by the highway department of one of our western States showed that of 100,673 lin. ft. of bridge structures on ten typical primary highways, 51,643 lin. ft., or 51.3 per cent of the total length, consisted of individual span lengths of less than 30 ft.

Special conditions, such as the current restrictions on material, for example, make an even greater use of short spans practicable. There are stream and other crossings where long spans are necessary in at least part of any permanent structure; but in many cases these sections of the structure can, in an emergency, be closed temporarily with a series of trestle spans, which can be maintained in satisfactory condition until material for longer spans is available. If the timber in these spans has been treated, it can then be reclaimed for use elsewhere; or in the event it should become advisable to continue the spans in service longer than contemplated, extensive repairs will not be necessary.

During the past fifteen years many highway de-



Cross-section of timber bridge, Wyoming State standard.



Shear developer and uplift lag screw; North Dakota plan.

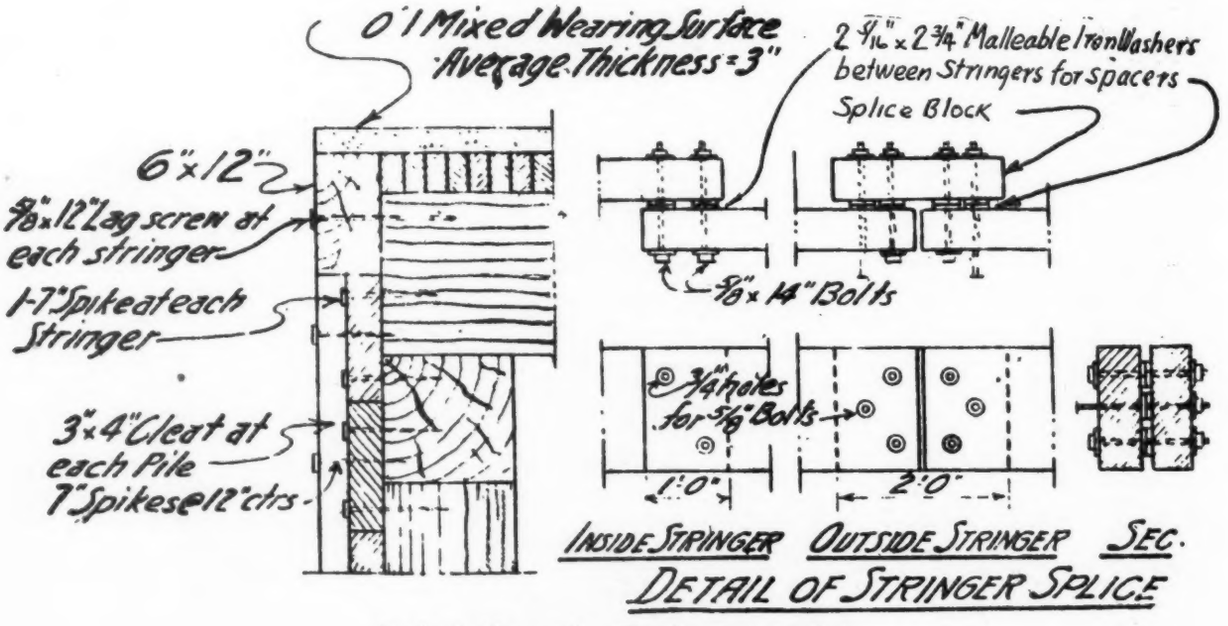
partments have developed standard plans for treated timber trestles, with span lengths varying usually from 11 to 29 ft. Prior to the last seven or eight years, timber bridges were usually the conventional trestle type employing large-size timber stringers supporting a reinforced concrete slab or a timber deck protected from abrasion by a wearing mat. While other designs have been developed in later years, this is still the most widely used type of timber bridge. As in the case of later types, it is easy to construct and can be economically designed for all standard highway loadings using commercial sizes of lumber for all members of the superstructure. Bridges of this type are readily widened to meet increased traffic requirements and can be cheaply salvaged with no serious loss of material, to be rebuilt at other sites in case of line changes or other developments that may make relocation desirable.

The economical panel length varies, of course, with the length of piles required for bents and the availability of stringer sizes suited to the different panel lengths. With ordinary bent heights and pile driving conditions, panel lengths of 15 to 21 ft. usually prove economical, the shorter lengths being used where large size timbers are at a premium. Stringer depths should not be greater than three times their width, since stringers not exceeding this height-depth ratio are stable against any tendency to lateral buckling and require no stress reductions. Suitable stringer sizes are sawed in quantity both from southern pine and Douglas fir, the two species furnishing the bulk of structural timbers.

The strip or laminated deck has largely superseded plank types, and it has some distinct advantages. Strips are in continuous contact, and, because of the narrow widths generally used, are not exposed to the severe edge loading possible in flat plank floors, where the plank can not be effectively connected one with another. Because of the slab-like construction, too, a greater distribution of concentrated loads is obtained. The strip type of deck permits the use of a considerable portion of short length material, since butt joints occurring over stringers in a percentage of the pieces do not seriously affect the strength of the deck if the joints are properly staggered and followed by full length pieces.

For ordinary roadway widths, splicing in one-third of the floor strips is usually permitted, provided: (1) It occurs over a stringer; (2) the shorter pieces are long enough to bear on at least three stringers; and (3) the spliced strips are followed by two strips of full length. For wide roadways all pieces must generally be spliced. This is not objectionable if the joints are staggered so that reasonable continuity of the strips is obtained. The strips should be nailed together with spikes of sufficient length to pass entirely through two strips and half way through the third. Each is toe-nailed to alternate stringers.

A treated timber deck should be protected from the abrasion of wheel traffic by some type of wearing surface. Otherwise the mechanical wear will impair not only the strength of the floor but also the effectiveness of preservative treatment, by reducing the thickness of the treated surface. The most suitable type of mat is usually determined by traffic. Under moderate traffic a 3 to 4-in. thickness of gravel with a bituminous treatment provides a satisfactory mat. Thicker layers may impose dead load increases that must be provided for in design. Asphalt plank has been used on many of the heavily traveled bridges, as have bituminous mats. Creosoted black gum plank, because of its resistance to mechanical wear, provides a serviceable floor without surface protection and is sometimes used as a wearing surface over subfloors of other species. Occasionally laminated floors have been built



Detail of stringer splice, Wyoming State standard.

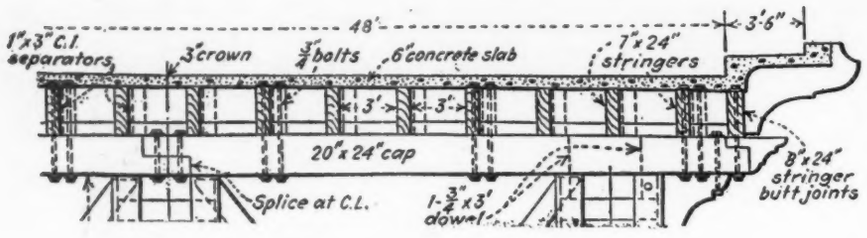
Bridge at Portland, Oregon, designed by State Highway Commission. Placing reinforcement before concreting deck. Note form work between rows of creosoted stringers.

entirely of creosoted black gum and have proven highly resistant to abrasion.

Probably no one detail does more to promote tightness and rigidity of the floor, and thus improve its riding qualities and durability, than the secure fastening down of the ends of the floor plank. The most effective method of doing this consists of bolting the curbs through the floor and outside stringers at intervals of about 5 ft., clamping the floor plank ends between the curb and the outside stringer. When the timber is pressure creosoted, moisture collecting at the joints will not cause decay, the scupper blocks necessary for aeration in untreated timber designs can be omitted and the curb bolted down tight on the floor with scuppers framed through the curbs at intervals or with drains carried through the deck near the inner curb line.

Solid bridging used in many of the newer designs is an improvement over the older X type consisting of pairs of 2 x 4s tacked between the stringers. An effective design consists of 4 x 12-in. blocks bolted to cleats, which are in turn bolted through the stringers. This type stays tight, reinforces the stringers, and provides a solid draft stop entirely across the bridge. On spans less than 15 ft. bridging may be omitted. For longer spans two lines are usually employed—one at each one-third panel joint.

Another all-timber type trestle built by several highway departments during recent years dispenses with the usual stringer system, using instead longitudinal laminated decks of sufficient thickness to span the usual panel of from 16 to 20 ft. For these panel lengths, 2 or 3-in. plank in either 8 or 10-in. widths are spiked together on edge to form a solid slab. In structures of two or more spans, joints occur in one-third of the laminations at a bent and in one-third at each of the quarter span points, thus providing continuity in the deck and resulting in more rigid construction than is obtained with simple spans. Rail and curb details are similar to those used in other trestle types. One bridge typical of this design, containing twelve 20-ft. spans and having 20-ft. clear roadway between curbs, was built in Harper County, Kansas, in 1939. The substructure consists of the usual 4-pile bents. The deck is composed entirely of 3 x 10-in. plank laid longitudinally on edge. End spans contain equal numbers of 16, 20 and 24-ft. lengths, but the interior spans are built entirely of 20-ft. lengths. This choice of plank lengths made it possible to arrange the joints in the uniformly staggered pattern mentioned above. The plank are fastened together with 60d spikes driven horizontally at about 12-in. centers. This length of spike passes through two thicknesses of dressed plank and extends into the third. Spiking is in two rows—one near the upper edge and one near the lower—the spikes in each being 24 in. apart. The deck was given an application of sealing compound mopped on hot and covered with a



Section of Oregon composite deck.

4-in. sand-clay surface. This surface, corresponding to that of the adjoining highway, is maintained with the rest of the road by routine patrol blade operations.

Composite Timber-Concrete Construction

During the last decade, two types of composite decks have been developed in which concrete and creosoted timber are combined to utilize each material advantageously.

In one type, developed by the Oregon State Highway Commission, the reinforced concrete deck slab is connected with the roadway stringers by a combination of daps and spikes in the tops of the stringers. These connections between deck and stringer are designed to develop adequate resistance to horizontal shear at the junction plane of the two materials to provide a T-beam in which compression is taken by the flange, which is the deck slab itself, and tension by the stem, which is the timber stringer.

The other type, developed by the Service Bureau, American Wood-Preservers' Association, is a composite slab, the upper or compression part of which is the concrete wearing surface and the lower or tension part a continuous laminated timber deck of thin plank on edge spiked together. The upper edges of alternate laminations are raised from 1½ to 2 in. to form longitudinal grooves of this depth. Shear connection between the two materials is provided by thin trapezoidal steel plates called shear developers, which are driven in the grooves at intervals, penetrating the sides of the raised laminations and the top of the depressed laminations, thus securing 3-sided support. (Described in *Public Works* for December, 1937.)

These composite types are in general adapted to the same span lengths used in other trestles. The concrete top in the composite types, however, provides an excellent wearing surface, and the combination of the two materials results in a more rigid structure than is obtained in the ordinary trestle type. Both composite types permit considerable architectural treatment where such treatment is desirable. The slab type possesses a further advantage in that it can be designed to act as a continuous beam over intermediate supports. A portion of the plank carried unbroken across the support and the concrete top reinforced for tension at points of negative moment provide a section capable of transferring considerable moment from midspan to the support. The distribution of moments in the slab can be controlled to considerable extent by various arrangements of joints in the laminations, since by proper arrangement relative sections are provided at midspan and support to obtain the optimum distribution of moments between these points.

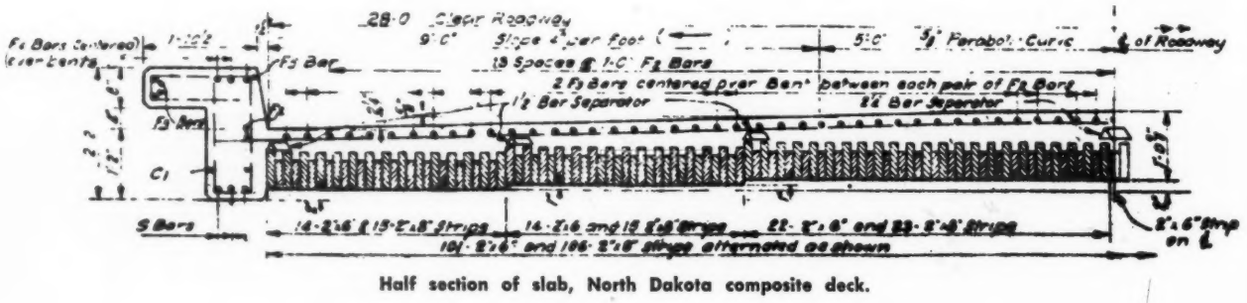
The timber in the slab base is nominal 2-in. plank, usually in 6 and 8-in. widths for normal panel lengths, a size that is ordinarily readily available. Furthermore, the high stress grades are unnecessary, since the strength of the slab is usually limited by the permissible compression in the concrete, and the slab is effective in distributing concentrated loads, such, for example, as a truck wheel over a considerable width of the deck.

Planks are usually ordered full panel length for all except the end spans of multiple span layouts, where shorter than panel lengths are needed for two-thirds of the pieces. In multiple-span structures where a continuous deck is used, one-third of the laminations are butt jointed at intermediate supports and one-third at or near each quarter-span point. Thus two-thirds of the pieces are continuous and, therefore, effective at these points, and a full timber section extends across the middle half of the span. No form work is necessary except at the edges along the curbs, as the timber deck has adequate strength to support the concrete load during construction.

The concrete mat is usually reinforced for temperature or shrinkage stresses throughout its length. Where it is designed as a continuous deck, additional bars are placed across the support where negative moment is developed and the top side of the slab is in tension. Typical reinforcing patterns are shown on the accompanying plans.

Acute shortage of reinforcing steel has been responsible for the development of designs omitting the usual slab reinforcement. These structures, which are similar in all respects to those built at an earlier date except for the reinforcement, have proven entirely satisfactory and give promise of further interesting developments. Construction joints or planes of weakness are placed in the concrete over intermediate supports, but the timber base is carried continuous.

Early in 1942 the Florida State Road Department built seven bridges of this design in which the usual reinforcing steel was omitted. These structures vary in length from a single 18-ft. span to a series of eleven such spans aggregating 198 ft. A construction joint



Half section of slab, North Dakota composite deck.

was made in the concrete across the roadway over each bent, thus keeping the concrete in compression except for the slight tension near the span end developed by continuity in the timber base. Some salvaged guard rail wire mesh was placed in the concrete surface as an aid in bonding together the concrete mass, but since the mesh is a collapsible fabric with interconnecting links it can not act effectively as reinforcement. None of the bridges was of sufficient length to require expansion joints, which in longer structures may be spaced at intervals of approximately 200 ft.

During construction a false bent with caps that could be wedged to any desired degree of strain was placed at each mid-span and removed when the concrete had set. Whether the construction joints at the 18-ft. span length interval were sufficient in themselves to prevent shrinkage cracking of the surface, or whether the prestressing by the false bents has also aided in this respect, is not known. At any rate, the surface is in excellent condition despite the absence of the usual reinforcing.

Timber Truss Spans

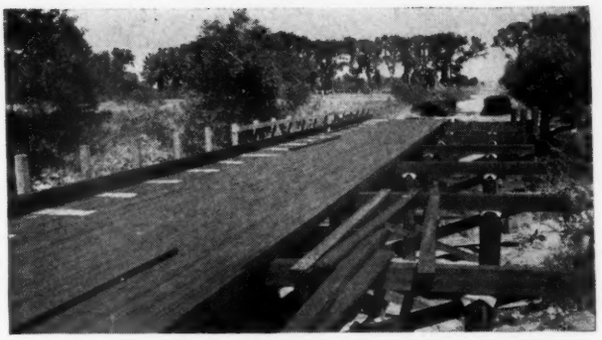
In the past, the timber truss was common for spans longer than those practicable in timber stringer construction. Their occasional use continued in sections where timber of considerable size was available, but in most instances other types of construction proved most economical. The older designs not only required considerable metal for rods and hardware, but required also an excessive amount of timber to provide adequate sections where chords were spliced. The introduction of timber connectors, however, removed these disadvantages, permitting economical chord designs and timber tension members in the web system. A number of such bridge trusses have been built in various sections of Canada and the United States during the past six or seven years with spans ranging up to 200 ft. or more. Most of these were erected before priorities were established and when other materials were competing. These structures have included through, half-through, and deck trusses. They were designed for standard highway loadings—usually either the H-15 or H-20, depending on their location and the class of traffic using the highway. Because of the difficulty in procuring large size timbers for floor beams on roadway widths of 24 or 30 ft., trusses framed from ordinary commercial sizes are frequently used for these members.

Built-up timber girders with webs of heavy plywood and flanges and stiffeners of ordinary lumber have received some attention in building design lately. Similar designs might provide practicable floor beams for highway bridges with wide truss spacing where timbers of adequate section are not available.

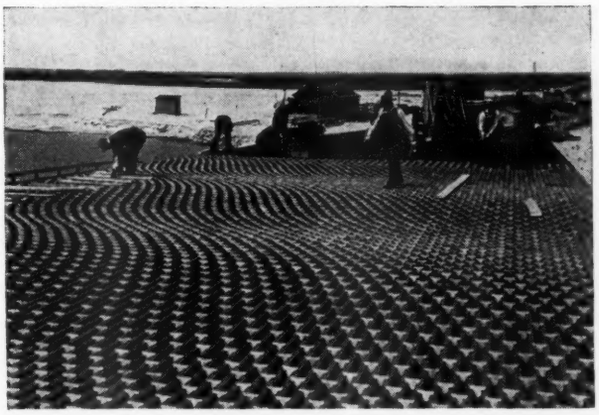
All truss timber is completely framed and bored at a framing yard or treating plant and the member marked before impregnating with preservative. Erection, therefore, consists in assembling the preframed members and bolting them in place, thus precluding the necessity for expensive carpenter work on the job.

Timber Culverts

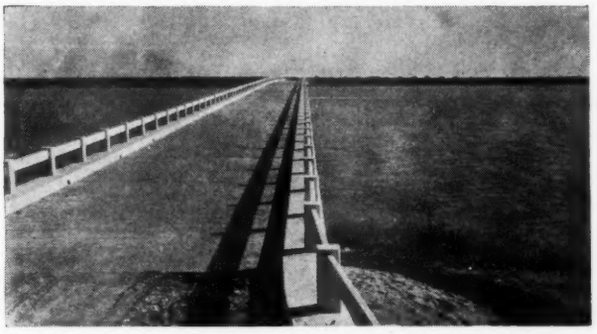
Creosoted timber culverts have been used in many places by both railway and highway departments. They do not deteriorate in alkali or acid soils and can be quickly constructed by unskilled labor at any season of the year. Common grades of lumber in random lengths are adequate, as high stresses are not developed. The ordinary rectangular designs are flexible and can be readily built "broken back"—that is, stepped to conform to side hill slopes. Drop inlets or cut-off walls are easily added.



Longitudinal laminated deck bridge in Kansas. Five 20-ft. spans and two 17.5-ft. end spans. Roadway 24 ft. wide. 3 x 18 in. plank used.

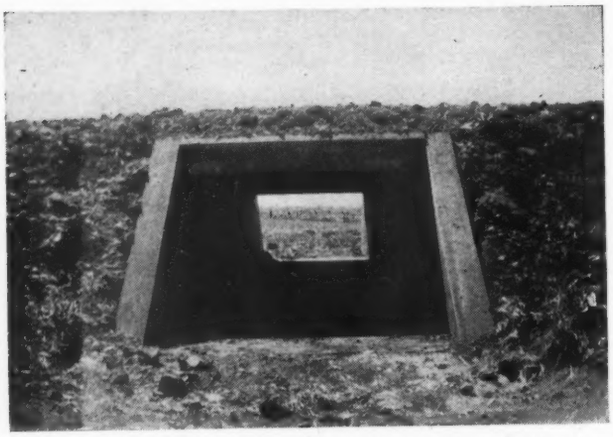


Base of Delaware Bridge. Shear developers driven in the longitudinal grooves to be embedded in the concrete mat.



Composite timber bridge across the Savannah river containing sixty-two 20-ft. spans and one 40-ft. beam span. Roadway 20 ft. between curbs.

One Kansas county with a considerable mileage of important highways has prepared standard plans for single, double and triple spans for both highway culverts and farm entrances. The sides are 2 x 4-in. or 2 x 6-in. plank of random lengths laid flat and spiked together to form a solid laminated wall. Vertical posts bolted as cleats through the wall along the back at intervals of 4 or 5 ft. reinforce the walls against lateral thrust. Culvert decks are laminated with strips on edge, 2 x 4-in. lumber being used for 4-ft. and 2 x 6-in. for 6-ft. spans. All material is treated with 10 lbs. of creosote per cubic foot by an empty-cell process. Stocks of treated timber in sizes and lengths required for the usual culvert sizes are maintained in the storage yard so that culverts can be built by maintenance crews at any time they are needed.



Creosoted box culvert, 6 x 3 ft., in Wayne County, Nebraska.

Prefabricated treated timber culverts are manufactured at several plants and sold in sections ready for assembly in the field. A rectangular type with interlocking sides, cover and bottom has been quite widely used both for culverts and storm sewers. Circular sections, which are heavy wood stave pipe built especially for culverts, are also manufactured and sold ready for assembly.

Built of pressure creosoted timber, these culverts are practically permanent structures, as is attested by the many railway installations that are in perfect condition after 30 and more years of service. Culvert timber, however, should by all means be pressure treated, since untreated or superficially treated timber used under conditions to which the culvert is subjected would require early replacement, thus entailing double costs that can be easily avoided by building with properly treated timber in the first place.

Preframing and Construction

The construction of properly designed treated timber structures involves very little framing on the job. In most of the newer designs the major part of framing consists in cutting members to the required length and boring the necessary bolt holes. This should be done at the plant before treatment. Exposure of the untreated interior wood to decay by cutting on the job is thus avoided, and the cost is less, since efficient equipment for framing is available at the plant. Pile cut-offs can not be avoided, but these can be effectively treated in the field, as only end grain surfaces are exposed; application of two coats of hot creosote and roofing with metal or pitch-coated fabric prevent loss of preservative and the entrance of moisture into the pile center. Where field framing can not be avoided, it can be limited to end cuts and boring bolt holes. Field treatments can be used effectively in these cases: the end cuts are sufficiently receptive to brush treatments to permit effective protection and bolt holes can be pressure-treated in the field. If holes are bored for a tight fit, swabbing before placing the bolt proves good protection. (See *Public Works* for April, 1939.)

Since there are contractors in every section of the country engaged in building highway bridges, pile drivers are available in most every locality. On large jobs, power-driven bits are desirable to save time and labor. On smaller jobs, that work is more frequently done by hand labor.

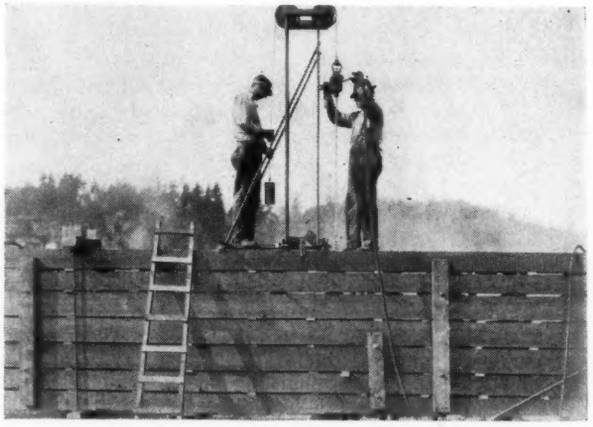
An illustration of the rapid construction possible with timber designs was the erection during the past year of a 286-ft. bridge with composite treated timber-concrete deck in six days' time by the Bureau of Yards and Docks near Norfolk, Virginia. Following a 7-day curing period for the concrete mat, this bridge was opened to traffic. It is on an important access road and has nineteen 15-ft. spans and a 30-ft. clear roadway. The sub-deck consists of 2 x 6-in. and 2 x 8-in. pieces alternating, laid on edge parallel to the roadway centerline, and spiked together to form a laminated slab. Bottom edges of the laminations are flush with the cap top, providing grooves on the upper surface for the standard shear developers, which have an average spacing of 14 in. in each groove.

Specifications and Stresses

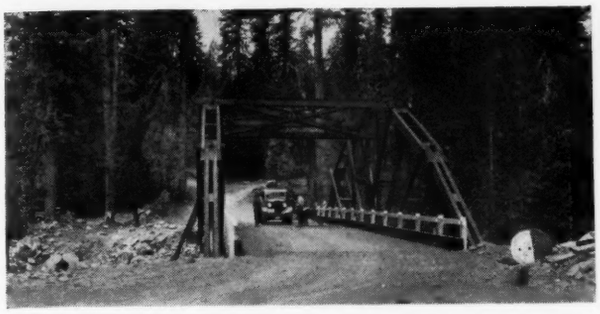
A standard highway bridge specification representing the collective experience of the several State highway departments has been published by the American Association of State Highway Officials and is closely followed by all agencies designing highway bridges. Conservative rules of design are given for proportioning members adequate in strength and rigidity to assure satisfactory performance and long service life. The range of loadings covers all classes of highways, and the necessary design assumptions for distribution and placement of wheel loads are set out in detail. The simplified specifications for structural timber conform to those published by the leading technical societies, and grade recommendations for various structural members represent standard practice.

The wider use of common grades demanded by present regulations can be effected in a great many instances without impairing the strength of the finished structure or lowering the factor of safety if the designer recognizes some of the fundamental properties of wood. Increasing permissible stresses to conserve material is common practice today. Timber working stresses are for permanent loading. The time during which a wooden member is loaded has an important bearing on the amount of stress causing failure. Much greater loads than those sustained in the laboratory tests can be carried safely for short periods. Stresses derived from these short-period tests are, therefore, reduced to take care of permanent loading. The load required to break a stringer in several years is only nine-sixteenths of that required to cause failure in five minutes. Increased working stresses for live loads which are in position for maximum effect only instantaneously are, therefore, warranted. This is particularly applicable to the rating of existing structures. Impact need not be considered in timber bridges since a moving load traveling at high speed

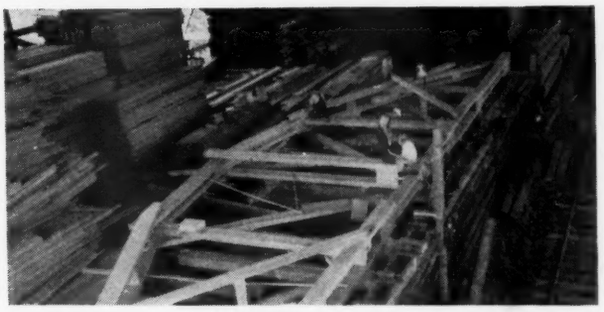
(Continued on page 37)



Bulkhead timbers assembled for boring, then dismantled and treated.



Dinkey Creek bridge, California, completed, with deck of 3 x 12's laid flatwise.



Fabricated members nailed together and bolt holes being bored.

Modern Methods in Constructing Timber Bridges

How connectors are used in building timber bridges, illustrated by progress photographs of the construction of a 90-foot through span with 20-foot roadway for H-15 loading.

IN the May, 1942, issue of PUBLIC WORKS, under the heading "Scientific Use of Wood in Structures", we said: "In 1933 the Committee on Wood Utilization of the U. S. Department of Commerce brought to the attention of engineers in this country the idea of connectors developed in Europe, and they have been used in many structures in this country. Meantime an intensive study was being made of timber and its uses by the Forest Service of the U. S. Department of Agriculture in the Forest Products Laboratory at Madison, Wis. Thus there now is available abundant information permitting scientific, economical and effective use of timber, in easily obtainable stock sizes from 2 x 4 to 3 x 12, for almost any kind of structure desired."

This article contained a description of connectors and methods of using them. One of the principal uses is in trusses, both roof and bridge and trestle. Concerning the latter, the author of an article appearing elsewhere in this issue, on "Designing and Constructing Creosoted Timber Bridges and Culverts," says: "The older designs not only required considerable metal for rods and hardware, but required also an excessive amount of timber to provide adequate sections where chords were spliced. The introduction of timber connectors, however, removed these disadvantages, permitting economical chord designs, and timber tension members in the web system. A number of such bridge trusses have been built in various sections of Canada and the United States during the past six or seven years ranging up to 200 ft. or more."

Among the bridges using "Teco" (Timber Engineering Co.) connectors are the following:

Johnson Creek, Ore. 60′ span, 20′ roadway. H-15 loading. Half-through deck roadway. Lumber—Douglas fir.

Cathlamet — Puget Island, Washington. Overall length of 1188′-3″, Douglas fir spans. 20 ft. deck roadway. 80′ clear span between truss supports.

Truss raised and ready to be placed on abutments.

Assembling the timbers at the bridge site and bolting together.

Rattlesnake Bridge, Cal. Three hinged arched. Span 108′. Rise 50′. Overall length, including approaches, 400′. California redwood.

Dinkey Creek, Calif. 90 foot span, through bridge. 20′ roadway. H-15 loading. Treated Douglas fir.

Dolan Creek, Calif. 180′ 3-hinged arch. Four 38′ latticed spans. California redwood.

Crabbe Roads, Ala. Two 90′ spans. Half-through deck bridges. Width 24′. H-15 loading. Treated shortleaf Southern pine.

Grenada, Miss. Several bridges for Army use. 60′ span. 24′ roadway. Half-through deck. Southern pine.

Baird Creek, Washington. Overall length of trestle, 1130′. Height, 235′. Three-hinged arch, 120′ span, 105′ rise. Douglas fir.

Detail of heel connection and method of hanging floor beams from truss verticals. Upper chord, two 6 x 16's. Lower chord, two 6 x 14's. Vertical posts, 6 x 16's. Floor beams, 16 x 30's. Floor beams are hung from verticals by steel straps and ¾ in. bolts, with 4" flush type shear plates placed in verticals.

Quantico, Va. 60′ span. 20′ roadway. H-15 loading.

Buffalo Creek, Penn. Through-deck bridge. Two 91′ spans. Overall length 182 feet.

Albermarle Sound, N. C. 3½ mile trestle.

Bear Canyon, Washington. Deck roadway. Spans, 120′ and 140′. Overall length, 440′.

Wood bridges today, as in the past, are often constructed of local species of lumber, but the outstanding projects have been constructed of the species that are generally recognized as being especially applicable structurally, such as Douglas fir and California redwood in the west, and southern pine in the east. Use

Both trusses, floor beams and bracing in place. Lower lateral (rod) bracing system in plane of floor beams being installed.

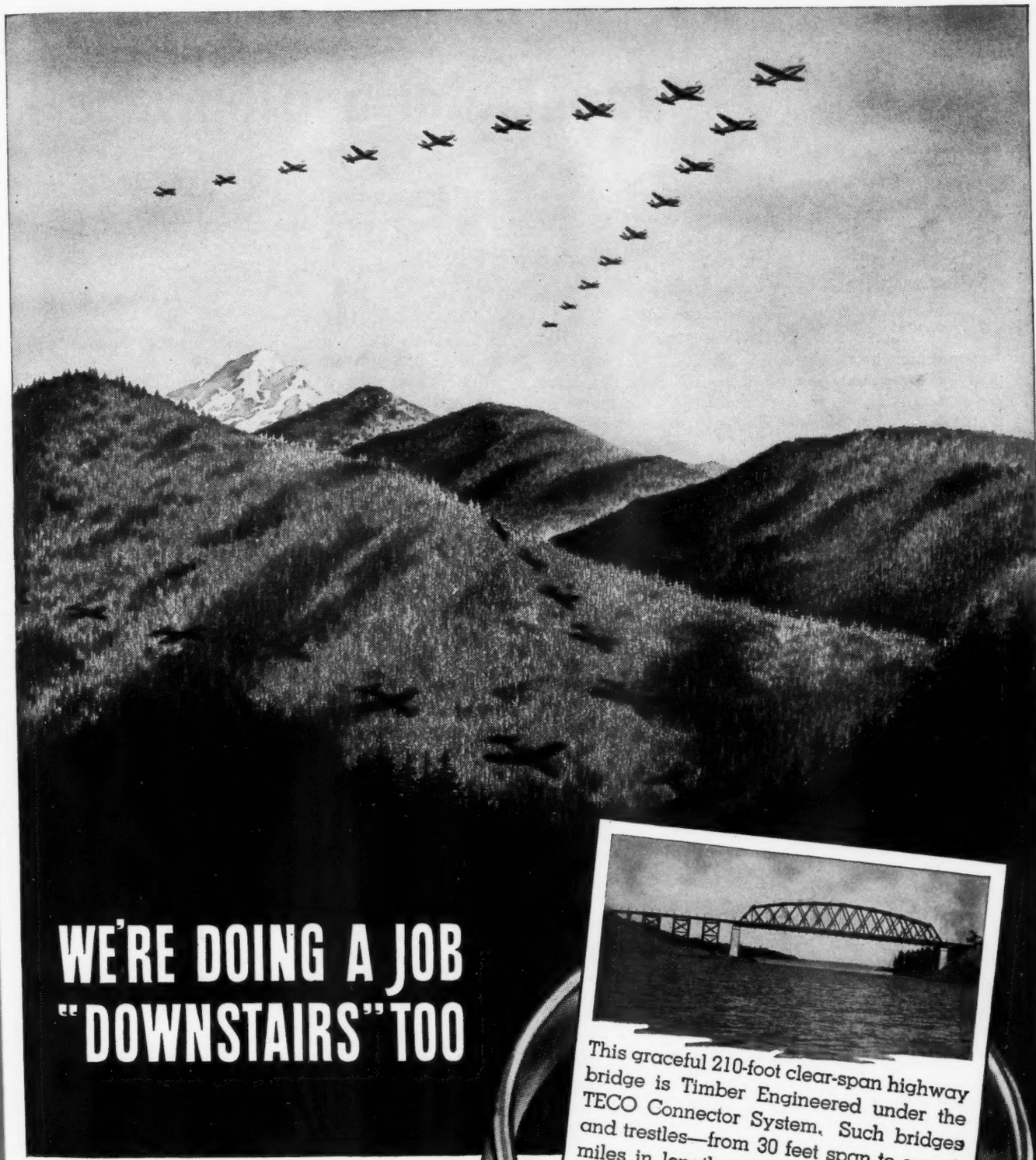
Details of upper lateral bracing system. 14 feet vertical clearance.

of timber cut at the bridge location loses its economical advantage if it is creosoted (as is desirable for any but temporary structures), since freight charges to and from the creosoting plant might easily be greater than the cost of creosoted timber direct from the lumber company.

It is desirable (though not necessary) that all the timbers for a bridge be framed and bolt holes bored before it is creosoted. This generally can be done better and at less cost at the lumber yard where the timber is purchased, permitting more thorough treatment of the ends and holes than is practicable by hand creosoting in the field.

The procedure of prefabricating the Dinkey Creek bridge, (after which the members were sent to the plant of the American Lumber & Treating Co. where they were creosoted), of assembling them into trusses at the bridge site and bolting them together, of erecting the trusses in place and completing the structure is shown pictorially by the accompanying photographs.

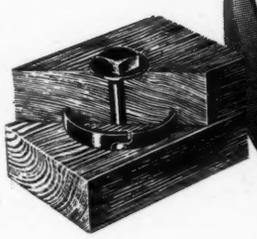
The design of a bridge using connectors differs from that where connectors are not used. Standard loads for different species of woods, location and spacing of connectors, effect of angle between direction of load and that of the grain of the wood, design of joints and other features, have been developed by experience and laboratory tests. A full explanation of these will be found in "A Manual of Timber Connector Construction", a 16-page bulletin; and twelve bridge designs of from 70′ to 30′ span are shown in detail in "Modern Timber Highway Bridges."



WE'RE DOING A JOB "DOWNSTAIRS" TOO

This graceful 210-foot clear-span highway bridge is Timber Engineered under the TECO Connector System. Such bridges and trestles—from 30 feet span to over 3 miles in length—are carrying today the ever-increasing volume of America's war traffic. You, also, can now use the TECO Connector System of timber engineering for Strength, Speed and Economy. *Write Us Today.*

The TECO Ring Connector spreads the load on a timber joint over practically the entire cross-section of the wood . . . brings the full structural strength of lumber into play.



Timber ENGINEERING COMPANY

WASHINGTON, D. C. PORTLAND, OREGON

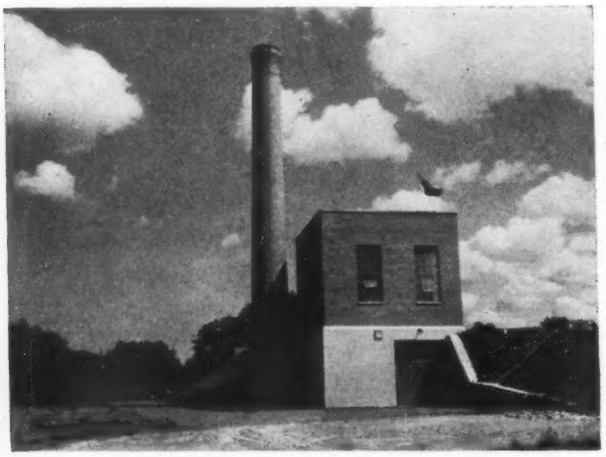
When you need special information—consult the classified **READER'S SERVICE DEPT.**, *pages 55-57*

Incinerator and Sewage Pla

A small village burns its refuse in an 18-ton incinerator, located at the sewage plant, which is operated by the sewage attendants and heats the digester.

FAIRPORT, NEW YORK, is a village of 4700 population located near the city of Rochester. For many years it had operated its own electric light and power plants at a profit, and in 1913 built a sewage plant at a cost of $6,500. This plant consisted of grit chambers, sedimentation tank and sludge drying beds. In 1930 additions to the plant were made, consisting of a separate sludge digester, trickling filters, final sedimentation tank, three additional drying beds and a pumping station, the cost of which was $77,500. At present the average flow of sewage through this plant is 375,000 gpd.

The disposal of garbage and other wastes had long been a major problem in the village. These had been disposed of on dumps, which were realized to be unsanitary and unsightly and were the cause of numerous complaints because of odors, fires, rats and other objectionable features. The State Board of Health strongly advocated burning all refuse and in 1939 an incinerator for burning garbage and rubbish was built near the sewage digester.



The incinerator at Fairport, N. Y.

Locating the incinerator at the sewage plant has demonstrated the advantages and economy of the joint operation of the incinerator and treatment plant. The same operators are able to attend both plants conveniently, and heat furnished by the incinerator is used to heat both the sludge digester and the incinerator building.

The total cost of the incinerator was $26,400. After investigating the proposition to utilize the aid of PWA or WPA, the taxpayers voted that the entire cost be paid by the village. The incinerator plans adopted included provision for heating the digester with hot water obtained by passing the heat from incineration over coils located in the combustion chamber of the incinerator.

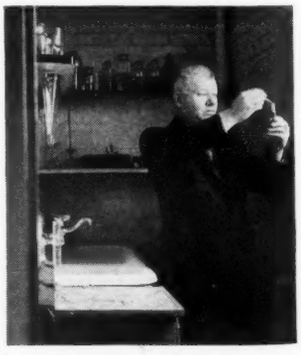
The incinerator is housed in a two-story concrete and brick structure 26x30 ft. by 30 ft. high. A ramp with an easy grade gives access to the charging floor, at the rear of which are two large charging manholes protected with heavy covers and an iron railing, one manhole receiving the moist garbage and the other the dry materials. Refuse is discharged by the trucks onto the charging floor and fed into these manholes by workmen. On this floor also are located an office, lavatory and a well equipped laboratory where sewage tests are made.

A steel staircase leads from the upper floor to the first or stoking floor. Here is located a Morse-Boulger incinerator with a capacity of 18 tons in 24 hours, which connects with a chimney 65 ft. high built by Wm. Summerhays Sons Corporation. The destructor contains three compartments, 1—a grate compartment for dry materials; 2—a drying hearth, consisting of two large arches or hearths for the moist materials; and 3—a combustion compartment for the burning of gases and odors, which is connected by a flue to the stack. An 8 x 10 x 12 ft. coal bin, built under the ramp, is connected to the stoking floor and is filled through a manhole at the top of the ramp. The stoking floor also contains a locker room with shower bath and a lavatory.

Each floor has a drainage system and the entire plant is flushed thoroughly after each day's operation.

The incinerator operates with a temperature of from 1000 to 1600 degrees and the ash and residue of the garbage and refuse is surprisingly small. The ashes and all noncombustible materials are put on a dump on plant property.

One very important factor of the new setup is the heating of the sludge digester by the waste heat of the incinerator. Four coils, each 35 ft. in diameter, were placed in the digester by suspending them from the top of the digester by means of angle irons 15 ft. long. (This work was done in cold weather in a very short time with no danger involved.) The waste heat and gases passing through the combustion chamber of the incinerator and over and around large pipe coils, which are connected to a 2000-gallon tank, furnish heat for the digester and also for the heating of the building.



F. Arthur Cary making a pH test in the Fairport laboratory.

Plperated Jointly

By F. ARTHUR CARY
Superintendent of Public Works, Fairport, N. Y.

Trickling filter. Final sedimentation tank in background.

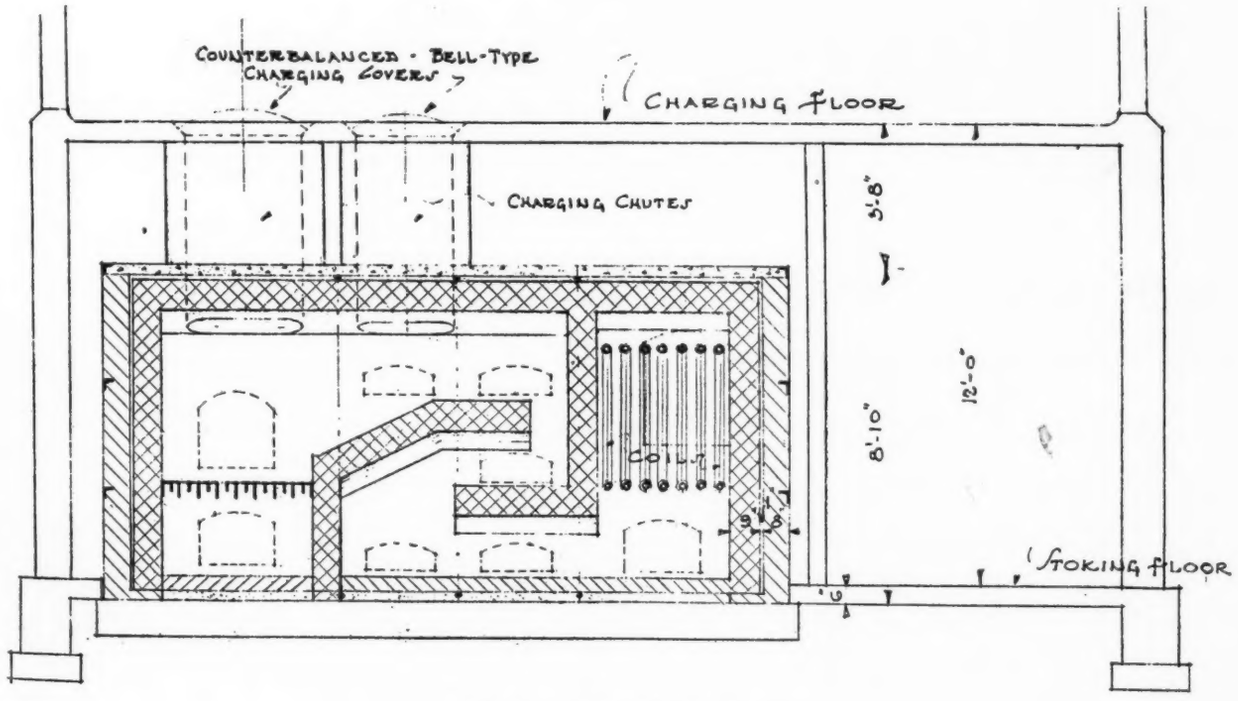
The 2000-gallon hot-water storage tank is located above the office on the charging floor. Suspended from the side of this tank are two Thrush hot water heaters —one heating water for the coils submerged in the digester, the other supplying heat for the building. When the incinerator is in operation the temperatures in the storage tank range from 180 to 210 degrees. All hot water used for washing or bathing comes direct from the large tank. Thus there are three separate hot water systems with no possible fear of contamination, a feature with which the New York State Health Department was much pleased. The water systems in the plant are supplied with Thrush circulators. A Thermoguide in the office indicates the temperature in the digester at all times. Being manually operated, the circulator is placed in operation whenever more heat is desired in the digester. The building heat is thermostatically controlled.

During the first year of operation, this heating system maintained a summer temperature in digester of 90 degrees and a winter temperature of 70 degrees. Before heating the digester, temperatures varied from 46 degrees in winter to 70 degrees in late summer. The ash content of the sludge from the unheated digester was never over 30%, while at present it has increased to 46.4%, showing the effect of heat.

After the first year of operation, it was found necessary and deemed wise to add an auxiliary heating unit to be used only during the coldest months. The incinerator is not operated from Friday until Monday, and during that period it was found that temperatures went down considerably in the digester and also in the building. For protection of incinerater and greater efficiency in sewage digestion, an oil burner was installed, and a 500 gallon storage tank placed outside at a cost of $392. This has taken care of the heating over the week ends during the coldest weather.

When the Village Board decided on the collection of garbage and refuse they were strongly opposed to curb collections. All refuse and garbage are collected from basements or grade doors, at the backs or sides of houses, thus insuring no unsightly curbs littered with rubbish. The pleasing appearance of our streets compensates for the extra cost of this type of collection, and is appreciated by the people of the village. The collection of garbage and ashes was started in June 1941. Two trucks, two drivers, and four col-

(Continued on page 38)



Longitudinal section through destructor.

Respectfully Submitted:

A report to our Customers including Uncle Sam

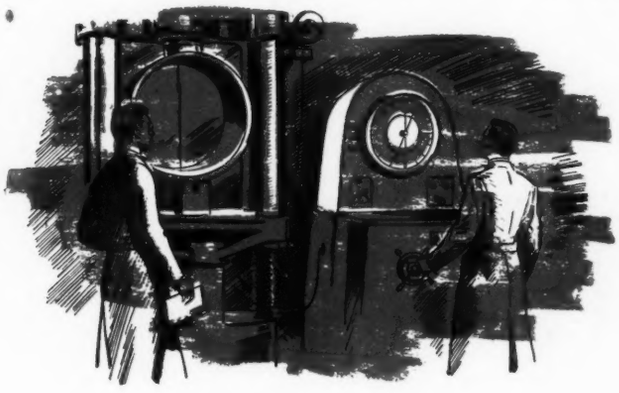
THIS is January—the first month of the second year since Pearl Harbor. We—the members of the Cast Iron Pipe Research Association—makers of pipe for water, gas and sewer mains—are still in the position of having thousands of customers but *only one* to whom we can *guarantee* delivery under wartime restrictions.

That No. 1 Customer is Uncle Sam. And in spite of increased capacities, our facilities have been strained to the last ladle to furnish cast iron pipe for *Army and Navy training camps; airfields; naval bases; ordnance arsenals; tank and airplane plants and shipyards, and their housing requirements, as well as essential civilian projects.*

Also, we are making or machining in our foundries and machine shops—*guns; shells;*

tank and plane parts; machine tool castings; liners for Diesel Marine engines; propeller shafts and other ship castings; chemical and other castings; presses for making armor plate, shells, and for dehydrating gunpowder.

To thousands of our customers, whose requirements for needed extensions of water, gas



and sewer mains we have been unable to supply, we have this to report: The clouds of war have a platinum lining.

When you can get the cast iron pipe you want, and need, it will be better than two years ago—*better than ever.* Our stepped-up wartime production alone would be bound to reflect progress in design and manufacture. The *plant research* of our members—the *field research* of our Association—the intensified *laboratory controls,* from raw materials to finished product, made necessary by greater production—are a continuing program.

For this *improved cast iron pipe* which we are delivering today to our No. 1 Customer—which few of our regular customers have had an opportunity to lay—we began to prepare ten years before Pearl Harbor. Two years ago, our co-operative study with leading consulting engineers representing pipe users, under the auspices of the American Standards Association, came to fruition in the adoption of the *A. S. A. Law of Design* for cast iron pipe in underground service.

We are now making cast iron pipe according to this new *Law of Design*—the most modern of all pressure pipe for water, gas and sewer mains—with all the inherent virtues of the cast iron pipe you have previously laid. This is pipe worth waiting for if your requirements for *permanent installations,* can possibly be deferred. We repeat—pipe worth waiting for. Cast Iron Pipe Research Association, Thomas F. Wolfe, Engineer, Peoples Gas Building, Chicago.

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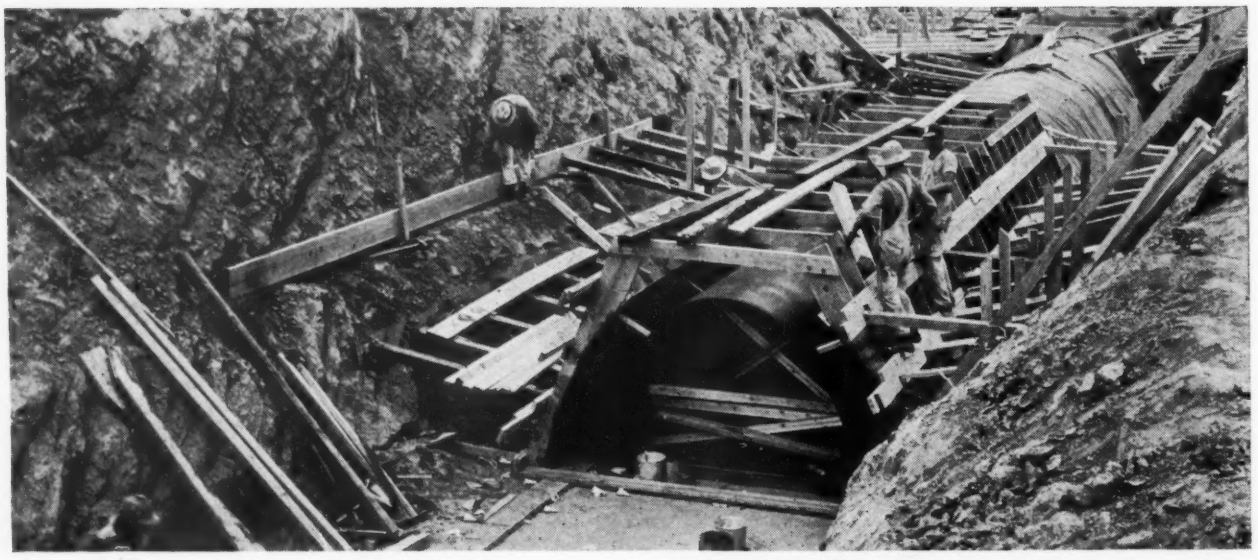


Inner form of storm drain, 2,500 ft. long, at Naval Reserve Air Training Station was built of steel plates, only enough for 60 ft. of forms being fabricated. Exterior forms were brought up only to the center of the inner arch form.

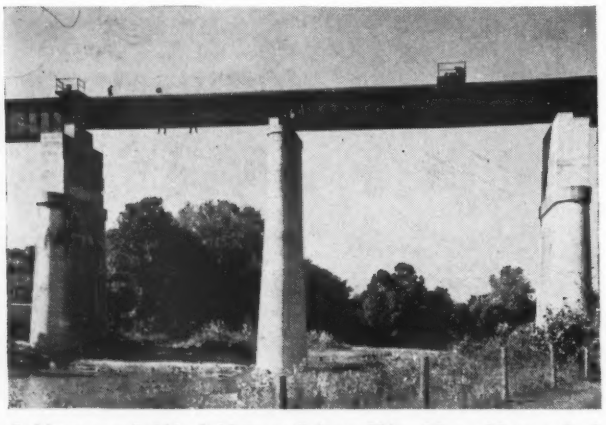
Minimizing Use of Critical Materials by Concrete Bridge and Culvert Construction

Specific examples of what has been done in repairing and replacing bridges and culverts to make them adequate for heavy wartime traffic.

RESTRICTION of motor-vehicle traffic to war transportation through nation-wide gasoline rationing does not imply any relaxation in the maintenance of main-line highway structures. On the contrary, it is probable that war transport will impose much heavier average loads than peacetime traffic has.

Repair of existing bridges becomes, then, a vital war need. Just as vital as this need, however, is the necessity for reducing the use of critical materials to the minimum both in the repair of structures and in their replacement.

The place of concrete in repair and replacement of bridges is becoming increasingly important. In the following paragraphs are given specific examples of what is being done.



Baltimore and Ohio bridge at Orient, Ohio. After old truss had been removed, concrete bridge seats were constructed on old piers and new pier built at center.

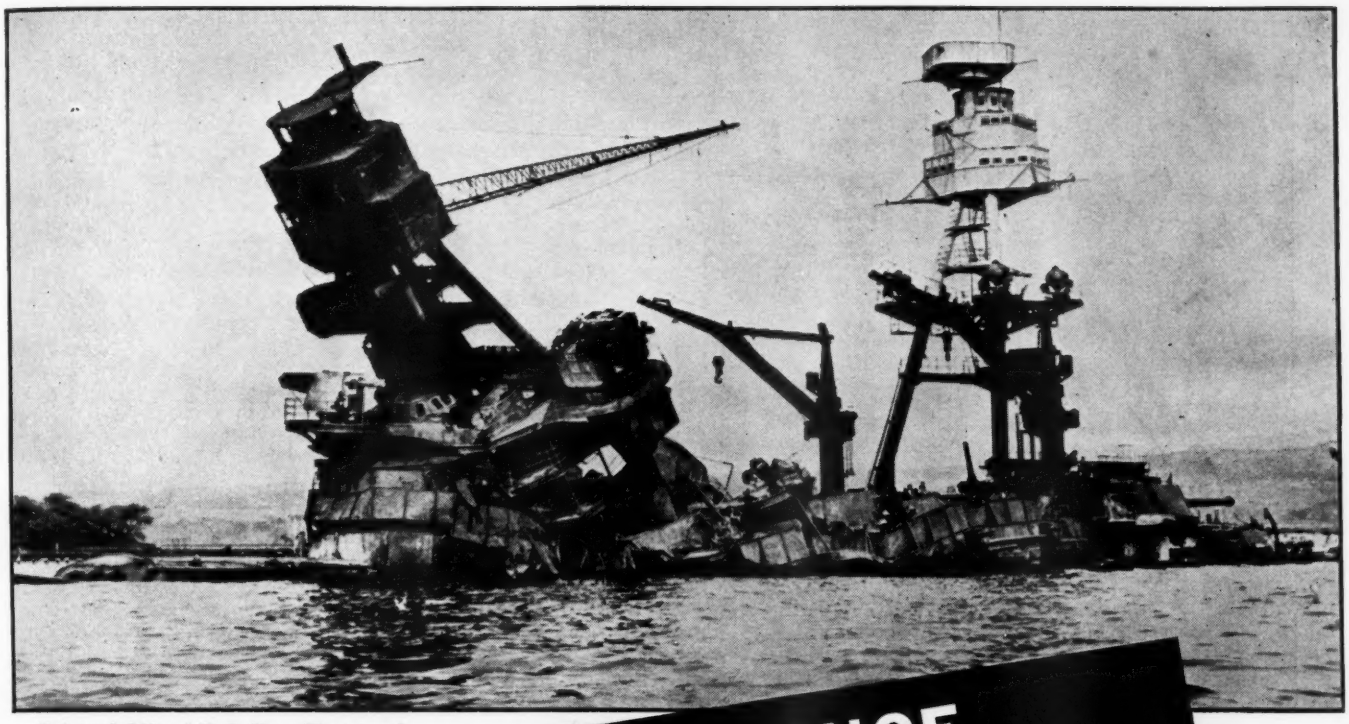
In new bridge construction, both rigid frames and bridges of the continuous type are replacing the more conventional types used so generally before the war.

Excellent examples of the continuous type concrete bridge are seven T-beam structures recently built in Michigan on a system of access highways to one of the world's largest bomber manufacturing plants. These structures were designed by the Michigan State Highway Department. According to Lester W. Millard, bridge engineer, "speed in construction was an important consideration, but economy of critical materials was the basic factor."

Because all seven structures—three-span jobs ranging in length from 128 to 195 ft.—were concentrated in a relatively small area, an attempt was made to harmonize them as a group as well as to make each bridge individually attractive. Special attention was given to the determination of relative span lengths and beam depths. Proportions of the resulting structures agree, Mr. Millard reports, with the recommendations for maximum economy made by authorities in the field of concrete design.

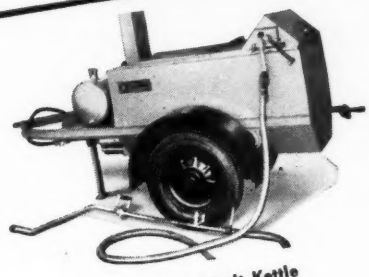
Where feasible, concrete structural members were made somewhat deeper than usual for normal working stresses, with a resulting saving in the amount of reinforcing steel. This practice follows the emergency recommendations of the American Association of State Highway Officials. Also, increased allowable unit stresses were used for the reinforcement, resulting in additional saving in steel.

Altogether, use of reinforced concrete instead of

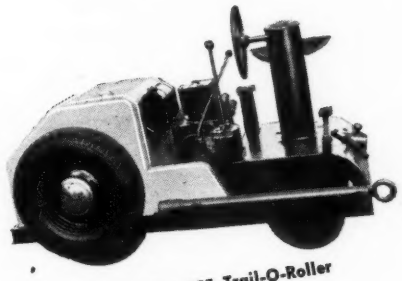


Released Official U. S. Navy Photograph.
U. S. S. Arizona in Pearl Harbor.

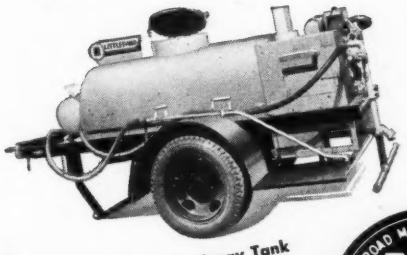
SINCE PEARL HARBOR



84-HD Asphalt Kettle



Model No. 155 Trail-O-Roller



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We have put our efforts to winning the war. We're in this struggle up to our necks and proud of the chance to do our part.

Needless to say, we are like most manufacturers—we cannot furnish equipment or parts without good reason. However, units now in the field doing important highway and airport construction or maintenance work can be helped through the Littleford Dealer Organization.

These Dealers have the facilities for repairing and servicing such Littleford units as 84-HD Kettles, No. 101 Utility Spray Tanks, Trail-O-Rollers, Burners, etc. If they do not have parts in stock, we will try to do all in our power to supply them.

Remember, Littleford equipment is helping to win the war by keeping vital roads, airports, streets, etc., ready for action.

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Kansas Highway Dept. concrete culvert; 9′ span, 7′ rise, unreinforced barrel arch, sliced off to roadway slope. Separate invert slab.

Construction of the above culvert in June 1942.

structural steel for the seven bridges and the increase in the allowable unit stresses in the steel saved 1,443,000 lb. of steel. Lower cost, also, was an item, and Mr. Millard estimates that the seven continuous concrete bridges cost 10 per cent less than the more conventional design.

Continuous Girder Bridges

Continuous concrete bridges in units of three, four or five spans, with concrete piles or frame bents for piers, are adaptable to almost any stream crossing or grade separation. For spans under 35 ft., continuous slab bridges are found most advantageous, while for spans between 35 and 150 ft. the continuous T-girder type offers an economical solution. For spans exceeding the range for solid-web T-girders, the continuous girder will be most suitable and economical.

Since continuous girder bridges are best proportioned when interior spans are 1.3 to 1.4 times the length of end spans for loadings and stresses in common use, this type of bridge is generally more satisfactory than one consisting of simple spans. The reason for this is that piers can often be placed outside the main channel for stream crossings and at roadway sides for grade separation structures. Cost of the substructure is thereby reduced, obstruction to stream flow is minimized, and the tendency to scour—present where large river piers are used—is lessened.

Since only single bearings are required at interior supports of continuous bridges, width of piers is reduced over what it would be for simple spans. Continuous bridges require few expansion joints, thus further reducing first cost as well as expense and bother of maintenance.

Besides substitution of rigid frame and continuous type reinforced concrete bridges for steel structures, the need for saving steel is leading to the design of unreinforced concrete arches of small spans. These structures are useful where stream flow is not considerable.

Plain Concrete Culverts

Several state highway departments have made use of plain concrete culvert designs. At least one plain concrete state standard has been adapted to nonhighway use: as a main storm drain at a southern naval air station. Though plain concrete designs may require a heavier section, they are, in general, just as inexpensive as reinforced ones. And since they use no steel, this is an added vital factor under war conditions.

The parabolic two-hinged arch type culvert is suited to construction with plain, unreinforced concrete because no bending moment is produced in the ring by uniformly distributed vertical load. Furthermore, by properly choosing the rise-to-span ratio, the moments due to other loads will be small in a culvert of this shape. Another feature of parabolic type culverts of great interest to engineers is the fact that mathematical formulas are easily derived and curves prepared by which these culverts can be readily designed.

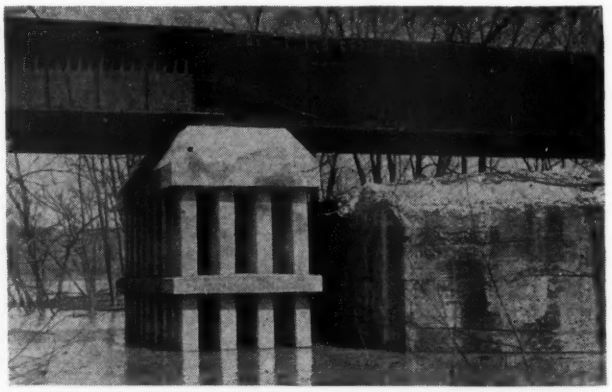
It is advisable to limit the lengths of spans to 20 ft. in structures of this type subject to impact or some unbalanced load such as in a culvert with a shallow cover and under highway loading. If sufficient waterway is not provided by an arch of 20-ft. span, it is recommended that two or more spans be used.

When the culvert is to be built upon other than rock foundation, the invert slab is designed especially to permit some rotation of the arch ring, while preventing horizontal movement, and is constructed to prevent appreciable bending in the slab itself.

If the culvert is built on rock, the rock should be excavated 6 to 12 in. at the arch supports, and the excavation should be reasonably smooth. Two coats of heavy asphalt should then be applied, and the area covered with 10-lb. tarred roofing felt. This will permit some rotation of the arch ring.

Lack of critical materials has fostered an interest in increasing the allowable unit stresses in reinforcement, as was the case in the construction of the seven Michigan structures previously referred to.

It must be borne in mind, however, that any in-



Pier comprising 36 piles stiffened by three horizontal diaphragms on the Chesapeake and Ohio R.R. replaces a combination old stone masonry and concrete abutment. During high water most of the pier is submerged.

A WARTIME MESSAGE

To Highway Officials and Engineers!

THE same principles of wartime conservation, that civilians practice with their automobiles and tires, apply with equal urgency in the matter of the nation's highways.

This year's needs are not for pioneering new routes or building new cross-country highways, but rather for protecting and saving what we've got—for dependable and economical maintenance that will preserve the three million miles of existing roads that are the world's greatest highway system.

We Americans know from experience that poor roads save no one money. There is no calculating what they cost in excessive wear to tires and automobiles, in delays to vital transportation and in lost opportunities. They do not contribute to winning the war, and they have no place in America's victory program.

For these reasons, as well as to protect the investments in the roads themselves, highway engineers and road officials are advised to concentrate much of their efforts upon maintenance for 1943.

If your own budget seems inadequate for all it must accomplish, remember there is a right type Tarvia and a right Tarvia method for almost every type of highway maintenance and repair. The Tarvia field man, backed by Barrett's 37 years of paving experience, will be glad to suggest quick and economical ways Tarvia can be used to provide the most miles of good roads for wartime travel.

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When you need special information—consult the classified READER'S SERVICE DEPT., *pages 55-57*

crease in the allowable unit stresses in the steel over what has generally been considered good design practice cuts down the factor of safety. In fact, reduction in the factor of safety is, for all practical purposes, directly proportional to the increase in the allowable unit stress.

The fact that structures can be produced in plain or reinforced concrete with a marked saving of critical materials without any sacrifice of structural effectiveness, life expectancy, appearance or cost advantages is making it possible to continue necessary construction.

Equally as important as conserving materials in today's highway construction and repair is the conservation of labor. In this, concrete offers a wartime advantage. Not only in new construction, but in the restoration and strengthening of existing structures otherwise scheduled for replacement, large economies of both materials and labor can be secured by using concrete. The following typical examples of what can be done, though taken from the railroad field, are equally applicable to highway structures.

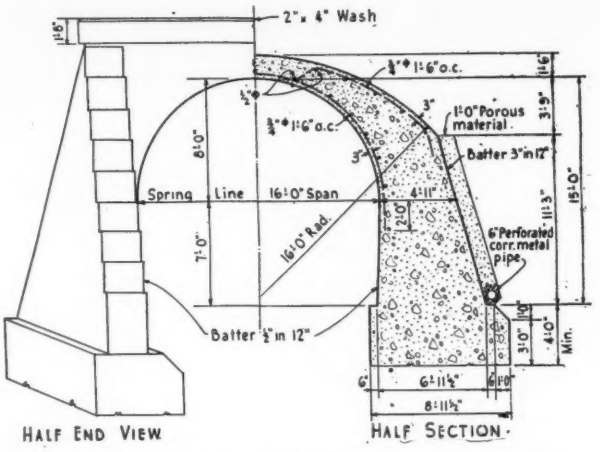
Under an old truss span in a bridge at Orient, Ohio, the Baltimore and Ohio R.R. in 1941 introduced a concrete pier, and used two second-hand girder spans with combined lengths equalling the length of the truss span removed. The change was made to permit removal of a "slow" order which had, for a long time, interfered with traffic because time was lost and train sizes were limited.

The Orient bridge consisted of a series of deck-plate girder spans which were adequate for modern traffic, and an old pin-connected truss which was far too light for present day loadings. Instead of rebuilding the truss span, other and shorter girder spans of adequate strength were transferred to Orient from a bridge whose use had been discontinued.

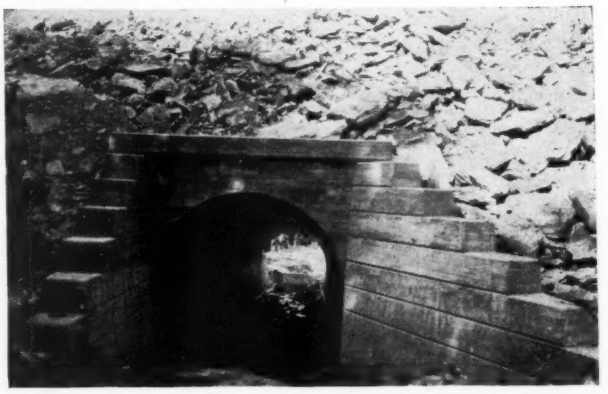
After the old pin-connected truss had been removed, concrete bridge seats were built on the old piers to accommodate the shallower girder spans. The girder spans from the abandoned bridge were then set on the built-up piers and on the new one.

The advantage of this reconstruction included not only placing the bridge in condition for unrestricted operation of main-line trains but the release of a large quantity of steel scrap. In addition, it yielded enough structural material to rebuild a smaller bridge, which included encasement of old stringers in concrete and construction of a new concrete ballast deck.

Storm drain at Naval Air Station completed—before being backfilled. Note the difference in color of concrete between that which was hand placed and finished and that which was placed against formwork. See illustration at head of this article.



Half end view and half section of culvert illustrated below.



Concrete arch of 16-ft. span built by the Baltimore and Ohio as part of a new freight spur track. Arch supports a heavy stone fill.

In designing an undercrossing during the time when the steel stringency was first becoming acute, the Pennsylvania R.R. changed from a structural steel design to that of a reinforced concrete structure.

On this structure the centerline of the railroad makes a 40-degree angle with the centerline of the highway. Presence of a number of switch tracks and special trackwork made it necessary to keep the deck of the bridge flat. The deck is of T-beam construction with the beams at right angles to the highway and resting on a center pier and two abutments. The center pier contains only nominal reinforcement, having a light grid in the top and a few vertical rods and ties in the shaft immediately under the bearings of the fascia girders. The spread footings are reinforced, but it is probable that these bars could have been left out by increasing the depth of the footing to make the offset less than the depth.

The Chesapeake and Ohio Railway is planning to use plain concrete arch culverts and mass concrete walls. These will be built according to standards in use on this line prior to 1910. The same type of construction will be used for extending existing structures.

Last year this same railroad made plans to widen a road from 30 to 42 ft. This involved removing the existing west abutment and building a new one for the longer span. The new abutment was first detailed as a highly reinforced cellular type consisting of thin side walls diaphragmed with thin cross walls and a central wall. Side walls were to rest on narrow footings and the cells so formed were to be open at the bottom.

When approval of the design was withheld because of the scarcity of reinforcement, the abutment was redesigned with unreinforced gravity walls.

In building a new spur last year to service a coal field, the Baltimore and Ohio R.R. built virtually a plain concrete arch of 16-ft. span instead of the structural steel span first contemplated. A small amount of reinforcement was used, but in many cases this could be omitted. An accompanying sketch shows a cross section of the arch barrel.

There are countless bridges in this country, especially on highways, which are inadequate for modern traffic weights and frequencies of load. Many of these have old stone masonry piers or arches. Normally, these inadequate structures would be replaced with modern structures. Now, however, emergency rehabilitation is called for where deterioration demands major repairs.

Much has been done on such old structures with pressure grouting. This can be speedily and inexpensively done on structures either where earth is retained such as retaining walls, abutments and solid spandrel arches, or on those not backed with earth such as piers and open-spandrel arches. There is ample technical literature on the subject of pressure grouting which is available gratis from the Portland Cement Association.

Designing and Constructing Creosoted Timber Bridges and Culverts

(Continued from page 24)

taxes their capacity less than an equivalent static load.

In addition, there is of necessity considerable variability in the individual timbers included in any grade range. Stresses established for the maximum defects permitted in a grade represent the low line and not the average piece, which is stronger. Then, too, the modulus of elasticity does not vary with the grade, remaining practically constant throughout the grades of each species. The duration of stress and other factors permitting increased working stresses for timber are discussed in detail in a paper, "Timber Structure," by Lawrence P. Keith, Assoc. M. Am. Soc. C. E., in Civil Engineering, October, 1942.

Present Conditions Increase Need for Durability

Conditions of supply at present and in prospect for some time more than ever place a premium on materials that can be depended upon to last through the emergency. Replacements must be reduced to an absolute minimum, since both material and labor reasonably may be expected to become increasingly scarce in the months ahead as war production is stepped up. Available grades of lumber, although short-lived in their natural untreated state, are highly durable when pressure creosoted. In fact, these grades with unrestricted sapwood are the most suitable for treatment, since they are more receptive to preservatives than grades with relatively high heart content. Besides the economy of avoiding replacements during the period when the conservation of materials and labor is of vital importance, there is the worth-while economy of salvage later on, where the structures are temporary.

Creosote, the principal preservative for structural timber, is not on the list of critical materials, and there is sufficient cylinder capacity available for treatment of all timber that is subjected to decay or marine borer attack. Moreover, treating plants are strategically situated between all sources of supply and points of use.

Rot Ruins Reputations

Here is an actual photograph of costly depreciation of bridge timbers that could have been prevented with Cuprinol treatment.

•

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Stops Rot!

Cuprinol, approved by the Armed Forces as a wood preservative, is a liquid, easily applied by brush, spray or dipping. It gives lasting protection to wood against rot and insect borers. You can use Cuprinol economically and profitably to preserve present or new construction and reduce costs of repair.

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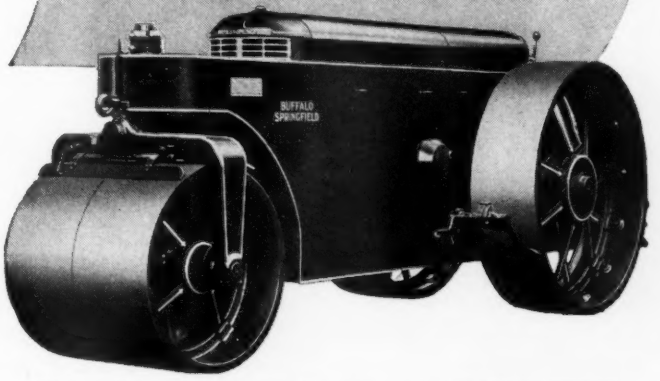

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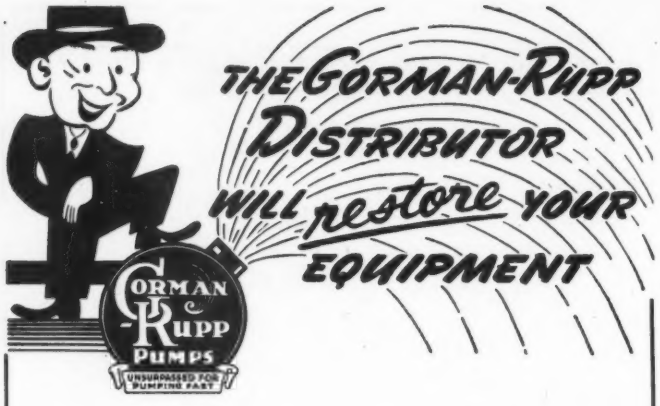

As more materials are diverted to essential war uses, new equipment becomes more difficult to get. Greater care must be given present equipment until after Victory. Let your Gorman-Rupp distributor restore your equipment to its original operating efficiency. They carry parts and repairs for all equipment they sell. Their charges will be reasonable.

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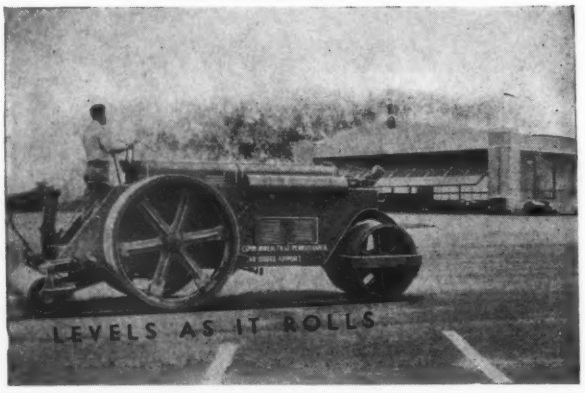

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Thus, treatment does not involve additional transportation, since lumber direct from the forests can be stopped in transit for proper treatment before it reaches its final destination without adding appreciably to the minimum haulage.

Incinerator and Sewage Plant Operated Jointly

(Continued from page 29)

lectors were employed for the collection from approximately 1200 homes and buildings. After a year, statistics are available showing—a saving in cost to the householder over private collections; and there is no more surface dumping, with all that went with it such as odors, breeding places for vermin and fire hazards as well as those to public health. These things are gone now and health conditions will be improved.

During the first year of operation, 1760 loads of garbage and 2050 loads of ashes and refuse were collected and burned. The following year 1852 loads of garbage and 2197 loads of refuse and ashes were collected. The cost of the collections was $9052.55, and the cost of operating the incinerator was $1303.85. We use bituminous coal as auxiliary fuel and the cost of that the first year was $391.91. Our figures for the second fiscal year of operation will vary little and will not be complete until March 1, 1943. After a period of two years the incinerator has proven its efficiency in every way and the heating of the digester has greatly facilitated the digestion of the sewage most satisfactorily.

Thomas J. Morrison of Rochester, New York, was the consulting and designing engineer of the project. M. Iuppa, Inc. of Rochester, New York, was the contractor. The combined plants are under the supervision of the writer, who would like to thank Frederick Plumb of Fairport for the photographs of the plant which appear with this article.

Highway Signs and Markings for Blackouts

Marking important highways so that essential vehicular traffic can move with comparative safety during blackouts may become one of the most critical traffic-control problems during the present emergency. In view of this, a study was made by the Division of Traffic and Safety of the Ohio Department of Highways in cooperation with the Public Roads Administration, of the effectiveness of various highway signs and markings. Passenger cars equipped with lights approved by the War Department were driven, during blackout conditions, over highways on which a large variety of standard and special signs and markings were installed. These included 27 existing signs and route markers, 12 standard signs, 45 special test signs, 8 interior-illuminated signs, 6 flood-lighted signs, and 20 symbols.

The main conclusions regarding highway signs and markings for blackout conditions based on the results of this study conducted under actual road and operating conditions may be summarized as follows:

1. Both urban and rural highways can be marked so that vehicles equipped with the approved blackout lighting system may be operated with comparative safety at speeds up to at least 20 miles per hour.

2. The need for highway signs, especially of the informational type, is greatly reduced while the need for pavement and object markings is increased.

3. Signs used during normal illumination are of little value. To be effective they must be either illuminated or reflectorized and mounted close to the roadway at the proper angle, with the top of their

6-inch legends within 18 inches of the elevation of the road surface.

4. Interior-illuminated signs are the most effective type and must be used whenever a legibility distance in excess of 75 feet is required.

5. Exterior-illuminated signs are most desirable where the same sign must be effective for both normal and blackout conditions. They are satisfactory on 2- and 4-lane highways where a target value in excess of 75 feet is desired and where there is no need of an average legibility distance in excess of 50 feet.

6. Reflectorized signs can be made that will be legible to drivers on both 2- and 4-lane highways, when properly placed, for a distance of at least 50 feet, which is adequate for most locations where a sign is necessary.

7. Reflectorized symbols are effective when properly placed; they are relatively inexpensive and should be used in advance of curves or intersections requiring a reduction in speed below 20 miles per hour.

8. Pavement and object markings to be effective must be reflectorized.

9. Visible centerlines are the most effective and necessary marking. They should be continuous on curves. Dashed centerlines are adequate on tangent sections of highways, providing the dashes are at least 10 feet long and the spaces do not exceed 20 feet.

10. Curbs and objects within the direct line of traffic must be marked.

11. Effort at the present time with respect to highway marking should be directed primarily toward installing markings that are most effective and necessary for both normal and blackout conditions.

Cotton Fabric for Lining Roadside Ditches

The Mississippi State Highway Dept. has tried cotton fabric for erosion control on roadside slopes and ditches on eight sections of highways having various soil conditions—sand-clay, clay, hardpan, rock and top soil. About 16,000 sq. yd. was used, in 40" and 54" widths. The mesh openings were 6 per inch in some cases and 4 per inch in others.

The results obtained on these eight experimental sections indicate that:

1. There is no apparent advantage in using cotton fabric on 3:1 or flatter slopes that have been treated with a mixture of grass roots and topsoil.

2. Use of cotton fabric has some advantage in shading growth and retarding erosion on 2:1 and 1½:1 slopes that have been treated with a mixture of grass roots and top-soil, or sprigged, or strip sodded. However, straw mulch serves better and is more economical wherever available.

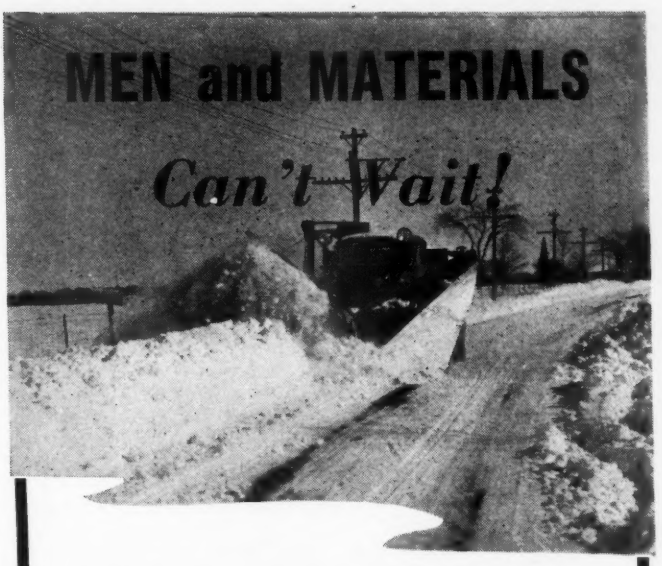
3. Cotton fabric aids natural growth and retards erosion on 4:1 slopes of sandy clay and clay soils that have received no other treatment. However, straw mulch serves better wherever available.

4. There is a definite advantage in using fabric in roadside ditch bottoms in promoting growth and retarding erosion. The fabric should be pegged at short intervals across its width to hold it close to the ground.

5. The S2-54 fabric is more effective than the other types. The open mesh of the S2 fabric allows vegetation to grow through it, and the wider material is more economical to install per square yard.

6. For greatest effectiveness, the fabric should be placed up and down on slopes and parallel to the flow line in ditches.

7. Galvanized wire staples are more effective than wooden stakes in pegging the fabric.



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Sewage treatment plant at Bagley, Minnesota.

The Sewerage Digest

Abstracts of the main features of all important articles dealing with sewerage and sewage treatment that appeared in the previous month's periodicals.

Animal Food From Garbage

A plant centrally located to serve six towns in the vicinity of Brighton, England, went into operation in May, 1941, the purpose of which was to produce a concentrate from garbage for feeding pigs and poultry. The aim is to produce a satisfactory product rather than make a large profit, but the scheme is "in a very satisfactory financial position." The concentrate has a ready sale with a long list of regular customers, at £4 10 s. per ton.

The garbage is heated and agitated in a steam jacketed vessel under an internal working pressure of 15 lb., thus sterilizing and thoroughly mixing it and evaporating surplus moisture. Besides the concentrator there are a steam boiler, a condenser and chlorinator (for deodorizing the escaping vapor), sorting platform, and bins for the charging and cooling. The cost of the plant, including changes in building to contain it, was £2,695.

About 2 tons of garbage is charged into the concentrator, cooked for 1 hr. 40 min. at a maximum temperature of 250°, discharged into bins and cooled for 24 hr., when it has the color and consistency of a plum pudding. To fortify it, 30 gal. of blood and 100 lb. of red offals to 60 bins of waste is now being added, raising the protein content by about 1% and the nutritive ratio to 1:6, the ideal ratio being about 1:5.

The sales have increased from 30 tons in June, 1941, to 303 tons in August, 1942. In August 309 tons was collected from a combined population of about 212,000, or about 1½ tons per 1,000 population.[D27*]

Operating Sedimentation Tanks

"Among the important factors requiring cognizance in operating separate primary tanks are: character of sewage, quantity and nature of solids from secondary treatment processes (where these solids are returned to the primary tank influent), type of sludge collection equipment, methods of sludge treatment, prevailing air temperatures, and the availability of operation personnel." Operation practices at 19 plants, located from Wisconsin to Texas and from Florida to California, are described in detail and discussed in 20 pages of the "Journal" under the headings: "Operation of Sludge Collection Equipment," "Sludge Withdrawal from Sedimentation Tanks," "Frequency and Times of Sludge Withdrawal," "Withdrawal Rate," "Operation of Sludge Thickening Tanks," "Sludge Measurement and Sampling," "Scum Handling and Disposition," "Skimming Methods and Devices," "Maintenance of Separate Sedimentation Tanks," and "Miscellaneous Sedimentation Tank Problems and Comments." The article is remarkably informative and valuable—too much so to permit of condensation.[C74*]

Maintenance of Sewage Plants

The following suggestions are based on experience at the St. Paul-Minneapolis plant.

Screens. In power-driven screen cleaners, rake arms have been strengthened and braced, and a more rigid rake cleaner and more effective shock absorbers installed. Chains are often kept too tight, causing excessive wear.

Grit removal. Grit scrapers, screw conveyors, belt conveyors and bucket elevators, all are abraded by the grit. Wearing shoes on the scrapers are the greatest item in maintaining these. The chains also wear. Worn sprocket teeth are rebuilt in place by welding on hard bronze. Screw conveyors present the greatest problem. Greased babbitt bearings had a life of about 2 months; they have been replaced with a hard-surfaced shaft revolving in a bronze bearing, the ends of which are sealed with rubber and a pressure water seal applied, these having a life of 2 years. In the lower pulley of the grit elevator, a similar change in bearings was made; the entire elevator housing has been lined with used rubber belting.

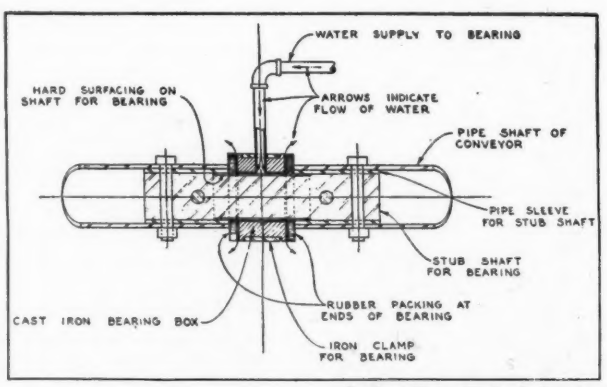
Pumps. Pumps for sewage should be of the closed impeller type, with wearing rings which should be maintained with reasonably close clearance. Sludge pumps are the reciprocating plunger type, using plungers heavier and of stronger material than standard. With centrifugal pumps, packing and packing sleeves are the main source of trouble; proper adjustment of packing glands and application of clear seal water solves most troubles. Keep packing gland nuts as loose as possible. Unbalanced impellers cause excessive wear of packing.

Vertical sump pumps cause very little wear. In submerged type pumps a clear water connection to the shaft housing keeps the bottom bearing clean and greatly increases the life.

Settling tank mechanisms. Wearing shoes show considerable wear in two years, and are hard-surfaced in place by spot welding with "Hasteloy" at a cost of 20 cts. each. Long chain and sprocket life require proper lubrication and chain tension. Chain tighteners have prevented chain breakage.

Concrete structures. Acid-resisting paints retard deterioration of concrete by sewage action. A common source of deterioration is repeated freezing and thawing—eliminate surfaces where water can accumulate.

Sludge dewatering. The sludge elevator chains, sprockets and bucket attachments have to be overhauled every 18 months. Corrosion is very severe in the conditioning tanks. Lime deposits on the vacuum filter screens and wooden framing are removed by filling the filter pan


WATER SUPPLY TO BEARING
HARD SURFACING ON SHAFT FOR BEARING
ARROWS INDICATE FLOW OF WATER
PIPE SHAFT OF CONVEYOR
PIPE SLEEVE FOR STUB SHAFT
STUB SHAFT FOR BEARING
RUBBER PACKING AT ENDS OF BEARING
CAST IRON BEARING BOX
IRON CLAMP FOR BEARING

Courtesy Water Works & Sewerage.

Intermediate bearing for grit screw conveyors.

*See Bibliography in the December issue.

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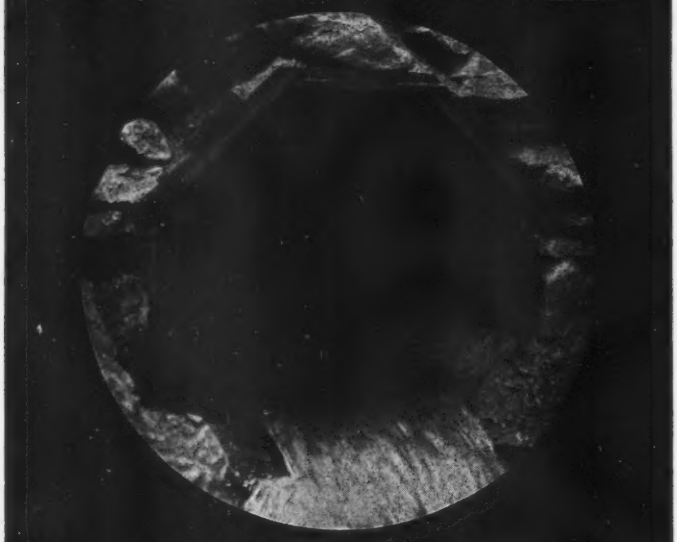
How to save STEEL



AND STILL GET

drainage

America at war can afford no interruption of vital traffic. Proper drainage is doubly important now. Yet desirable as it is, steel must only be used where engineering integrity demands it. Even so, perhaps we can help you.

For example, ARMCO Emergency Pipe may be just the answer to your wartime drainage problems. This completely new design in wood pipe requires no steel sheets, bands, wire mesh or metal reinforcing. It is easy to handle and has ample strength to meet engineering standards. ARMCO Wood pipe is designed to last through the emergency. On more permanent installations, when replacement becomes necessary, a corrugated metal pipe may easily be threaded through or jacked around the wood structure.

Remember that ARMCO Corrugated Metal Pipe is only on temporary "leave of absence." It will be back with its flexible strength, ease of handling, tight joints, long lengths and low installation costs.

Meanwhile, can we assist with your drainage problems? The answer may be in the use of non-strategic materials, or in suggestions for repairing older structures. Write. Armco Drainage Products Assn., 35 Curtis St., Middletown, Ohio.

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with clear water and inhibited hydrochloric acid and revolving the drum in it. (See C 64 in November Sewerage Digest). Corrosion on valves of vacuum pumps reduced their life to one month, which has been increased to 4 or 5 months by substituting valves and valve springs of stainless steel alloy.

Incinerators are of the rabble arm multi-hearth type; designed for use of air preheaters, but these are not necessary and have been removed.

Painting. The most important requirement is preparation of the surface; it should be thoroughly cleaned and dried. The best paint uses Tung oil varnish and aluminum or other metallic pigment. As these are now strategic materials, trial is being made of enamels of both synthetic and oil base, which have proven very satisfactory so far.[G1]

Advances in Sewage Treatment

The capital sums spent for sewage treatment and intercepting sewers by 24 of the largest cities up to Dec. 31, 1940, ranged from $9.60 to $44.07 per capita. The largest rectangular basins for raw sewage sedimentation with straight-line sludge removal are 290 x 56 ft. by 15.5 ft. deep at Minneapolis-St. Paul, and 270 x 117 ft. by 14 ft. deep at Detroit. The largest with rotating mechanism are 170 ft. diameter at Baltimore. At Bowery Bay the straight-line mechanism travels from inlet to outlet and at 2 or 3 times the usual velocity.

There are more than 106 activated sludge plants in the U. S. blowing through air diffusers, the largest at the Chicago West-Southwest plant (800 mgd). The trend is for smaller quantities of air, shorter periods of aeration, carrying a lower suspended-solids content in the mixed liquor, and maintaining a minimum depth of sludge in the final settling basins. Where the sewage is low in ferrous iron there is little clogging of diffusers; but where it exceeds about 5 ppm, clogging has occurred within a year. At Chicago, 90% of the plates are operating satisfactorily after 12 years' use with no cleaning. There are over 131 mechanical aerators in the smaller plants. Five cities dewater and heat-dry activated sludge for fertilizer.

Trickling filters increased from 371 in 1926 to 1486 in 1940. High-rate filters are increasing in number for the smaller plants, operating at rates as high as 10 times the normal. They are especially applicable for treating the stronger industrial wastes and for the smaller municipalities and institutions. At the end of 1941 about 137 high-rate filters had been installed, the largest for 5 mgd.

Chemical precipitation is now rated as a process producing an effluent better than plain settling but not equal to activated sludge or trickling filters. There are four Guggenheim plants treating municipal sewage and three industrial wastes, and two municipal plants under construction.

Chlorination is being used to control bulking of activated sludge, for sludge concentration, chemical coagulation, and removal of grease in pre-aeration tanks.

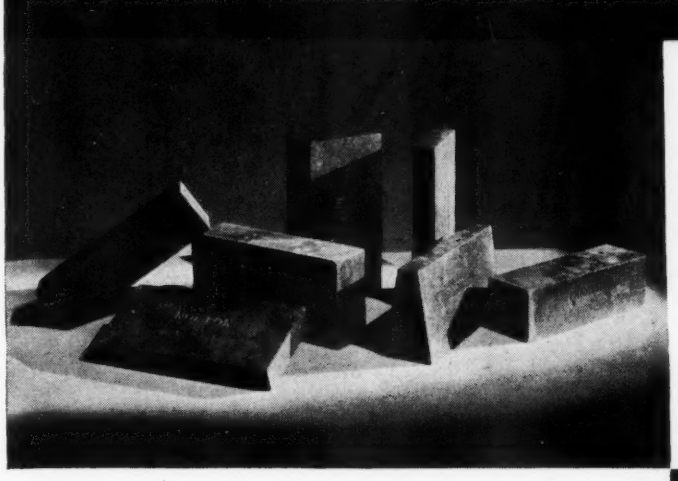
The Putnam process has been installed in four small towns, abandoned at one. The Hayes process has been installed at a few cantonments and small towns.

Most developments in sludge disposal during the past four years have been in vacuum filtration, heat drying, and incineration. There were, in 1941, 10 flash-drying installations and 7 multiple-hearth, the former apparently excelling for producing fertilizer (58,000 tons per yr.). Lagooning sludge has been practiced by Indianapolis for more than 15 yrs.; by Chicago as a temporary measure. Seeding the lagooned sludge adequately with supernatant and digested sludge is advantageous. There are 12 sludge elutriation plants in the U. S. In 1941, 112,012 tons of heat-dried activated sludge was sold.

There are about 23 magnetic filters filtering effluents from activated sludge, high-rate trickling filters, chemical precipitation and plain sedimentation; also five rapid sand filters for effluent filtering.

Aluminum pipes failed in a digestion tank after 20

Norton POROUS MEDIUMS — *Filtration-Aeration-Incineration*



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FOR INCINERATORS

For municipal incinerators Norton *Crystolon* (silicon carbide) brick provide great refractoriness at high temperatures. They are chemically resistant to the erosive action of slag and so dense that molten ash will not take hold by penetration.

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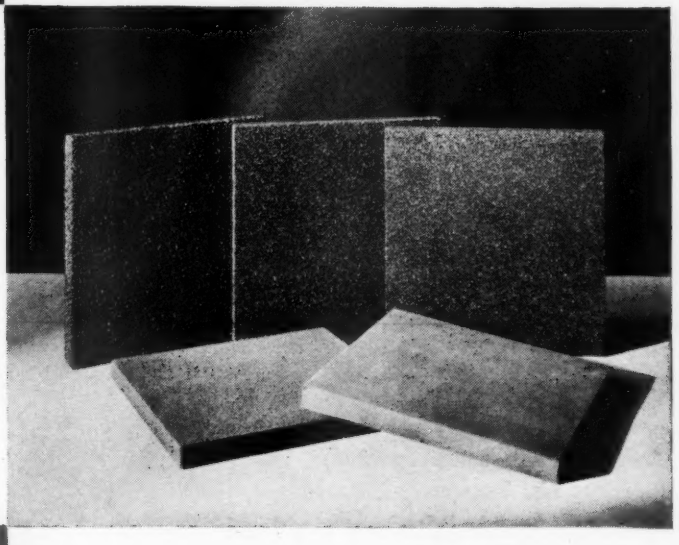
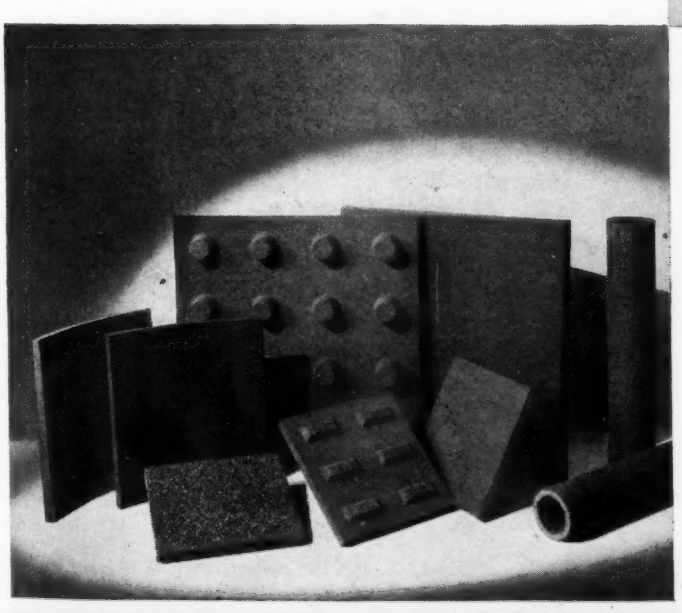
FOR RAPID SAND FILTERING

Because they are ruggedly designed, chemically stable and uniform, Norton Porous Plates are being selected for rapid sand filtering. Special plates with legs are available when substructure is not desirable. The plates can be joined by durable cementing and caulking materials, and rabbeted or beveled edges can be supplied.





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"Controlled structure" in the manufacture of Norton Porous Plates and Tubes assures uniform air distribution and regulated wet pressure loss. These efficiently designed Porous Mediums will deliver air to the sewage in amounts and at rates of flow calculated to give the best results.

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NORTON ELECTRIC FURNACE FUSED POROUS MEDIUMS

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months use and in a final settling tank. Steel sludge digester parts have corroded.

Garbage is mixed with sewage at three plants, where primary sludge is digested. Ground garbage is mixed with sludge and incinerated at three plants. Dumping ground garbage into the sewage and dewatering the mixture is of doubtful value.[K4] *

Financing Sewage Treatment Projects

The following methods have been used: a—Taxes and borrowings through general obligation bonds. b—Funds contributed by constituent municipalities within the district. c—Special assessments on benefited property. d—Appropriations by the state. e—Voluntary contributions. f—Revenues from service charges and loans secured by revenues. The trend has been toward the last. Of 1524 projects aided by PWA, 230 were financed by revenue bonds. Experience in selling revenue bonds and collecting revenue has been satisfactory. There is need for a further clarification of the structure of rate schedules for sewage disposal service and a classification of present experience in the light of fundamental considerations.[K1]

Land Fill At Army Camps

Hundreds of Army camps and posts are using or planning the sanitary fill method of refuse disposal, similar to that used by some municipalities, but using a "bull clam" shovel. This mechanism, attached to a tractor, acts as a scraper, a bulldozer and a power shovel; excavating trenches, leveling refuse piles, digging, moving and spreading cover fill and compacting deposited material. Land fill requires one acre for a population of 10,000 troops over a period of one year. Where frost penetrates 24 in. or more, hay or straw is placed over the surface of the ground to be used, or trenches are excavated in advance, the earth stockpiled loosely and covered with hay or straw. During the cold season a 6 in. earth cover is satisfactory. Settlement may continue for 5 or 6 years, and no buildings of considerable weight should be placed on the area during this period. Equipment desirable is one 35 hp tracklaying tractor equipped with a 1 cu. yd. bull clam for a camp of less than 20,000 population; for 20,000 to 50,000 population, a ⅜ cu. yd. tracklaying power shovel fitted with a 30 ft. boom and ⅜ yd. dragline bucket; for over 50,000, a ¾ yd. shovel and bucket, with a 40 ft. boom.[E2]

Trickling Filters For the R.C.A.F.

Trickling filters have been designed for the Royal Canadian Air Force camps that "combine the merits of both bio-filter and aero-filter to some extent." Provision is made for increasing efficiency by forced-draft air. The system is largely the bio-filter with added provision for varying the recirculation of effluent, from the influent or effluent of secondary tanks, to either primary settling tank or into the siphon chamber. They are designed for 6 to 9 mgad; depth 5 ft.[M1]

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

D

The Surveyor
November 6

1. Agricultural Activities on Sewage Works. P. 377.
2. *p*. Some Recent Developments in the Biological Treatment of Settled Sewage. By M. Lovett. Pp. 381-383.

Something Sure IS Wrong Here!

You bet it is! Any property owner would be sore if it took you all day to remove a stoppage that backed up water into her basement!

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November 20

3. *p.* East Newport Main Drainage Scheme. By Colin Cobbett. Pp. 397-399.
4. *p.* Biological Treatment of Settled Sewage. Discussion of D2. Pp. 401-403.

E *Engineering News-Record*

December 3

1. First Aid for Sanitation Needs. Pp. 73-74.

December 17

2. Landfill Disposal Wins Army Favor. Pp. 75-77.

G *Water Works & Sewerage*

November

1. *p.* Sewage Plant Maintenance. By Stanley J. Larsen. Pp. 457-464.

H *Sewage Works Engineering*

December

1. A Peacetime Treatment Plant for War Production Industries. By Elmer Mesner and N. L. Nussbaumer. Pp. 600-604.
2. Sewage Treatment Plants in U. S. A. Pp. 615-616.

J *American City*

December

1. Guarding a City's Health with Sewage Treatment (Tifton, Ga.). By D. H. Hurst. Pp. 38-39.
2. "Duration" Sewage Treatment (Baltimore, Md.). Pp. 69-70.
3. About Fly Ash. By Henry W. Taylor. P. 77.

K *Proceedings, Am. Soc. of Civil Engineers*

December

1. Organizing and Financing Sewage Treatment Projects. By Samuel A. Greeley. Pp. 1727-1742.

M *Water and Sewage*

November

1. *p.* Sewage Treatment for the R. C. A. F. By Trickling Filters. By G. Graham Reid. Pp. 29, 85, 86.
2. *p.* Chlorine in Sewage Treatment. By A. E. Griffin. Pp. 30-31, 48-56.
3. *p.* Operating Results at the North Toronto Sewage Treatment Plant. By Norman G. McDonald. Pp. 32-33, 58-63.

P *Public Works*

December

1. *p.* Wartime Problems in Refuse Collection and Disposal. By Wm. A. Xanten. Pp. 16, 20.
2. Sewage Treatment Plant for a Home for Mental Defectives. By B. V. Howe. Pp. 22-23, 42.
3. *p.* Humus from Rubbish and Sludge. P. 28.
4. A Dry Well Replaces a Wet One for Pumping Sewage. By Richard W. Halteman. P. 40.
5. *n.* Responsibility for Flooding by Sewer. P. 40.

Compensation for Extra Work Under Sewer Construction Contract

Action was brought against a municipality for the unpaid balance of the contract price for the construction of a sewer; also for extra work not specified in the contract and for extra work on order of the municipality or its engineer, and for material left in place in excess of the quantities called for by the contract and for sheathing. The municipality alleged there was no authorization for the extra work or material and counterclaimed for damages, alleging improper construction because the sewer leaked in excess of the maximum seepage allowance fixed by the contract.

Both parties appealed from a judgment for the plaintiff for the balance due on the contract. The contractor appealed from the judgment disallowing its claim for extra work and material. The New Jersey Court of Errors and Appeals, (Romano v. Borough of Metuchen, 124 N. J. L. 574, 13 Atl. 2d 680) held there was no merit in this appeal because the extra work was not made the subject of "a separate contract" between the parties as required by the contract which they signed and this requirement was not waived by the municipality.

The basis of the municipality's appeal was that the sewer admittedly leaked or was subject to infiltration in excess of the maximum allowance, and its counterclaim was for what it was compelled to pay to make the sewer watertight. The trial court found that the work was done under the constant supervision of the municipality's engineer, that after the chief engineer had awarded the contractor a certificate of completion the municipality took possession of the sewer and that several hundred connections were at once made; that many of these were inexpertly made and that by its act of taking over the sewer the municipality had accepted it in fact and waived formal acceptance. The appellate court agreed with these findings and affirmed the judgment.

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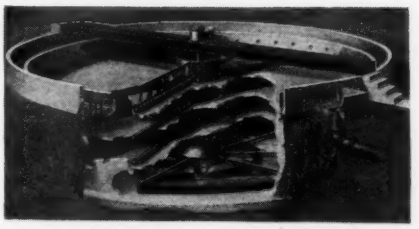
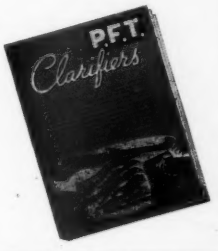
Prime faster, pump full volume, pump more hours. 1½", 2", 3", 4", 6", 8", 10"; capacities to 240,000 G.P.H. Send for catalog. The Jaeger Machine Co., 400 Dublin Ave., Columbus, Ohio.

P.F.T. Clarifiers for Rapid Precipitation of Sewage Solids





The P.F.T. Tray Clarifier embodies a design which effects the continuous rapid separation of the solids and liquid in sewage; and the immediate removal of the clarified effluent. A series of shallow settling areas over which the sewage is spread assures speedy precipitation. Its high rate of flow provides maximum capacity in minimum space; reducing the construction and operating costs of clarification equipment.

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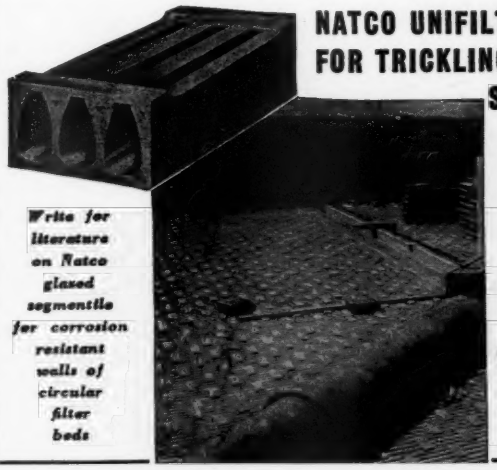

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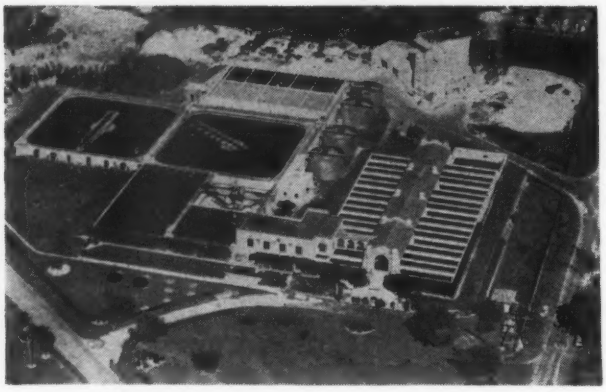


Aerial view of the Miami, Fla., water purification plant.

The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

Repaving Street Excavations

Of the water departments of 59 cities replying to a questionnaire, 47 are held responsible for cuts they have made in pavements, until the permanent repairs to them have been made; the other 12 are relieved of responsibility when the backfill has been completed or, in some cases, when temporary surfacing has been placed.

Fifty departments make temporary repairs, 12 using cold patch, 7 double layer repair, 6 oil surfacing material, 6 planking or old material, 5 premix, 5 cinders or gravel, 3 relaid brick or surfacing material, 2 broken stone, 2 old asphalt pavement partly reconditioned, 1 a thin layer of material similar to the original pavement, and 1 shell. In most of the others, temporary repairs are made by another city department.

The average costs per sq. yd. for permanent repairs are: Asphalt, $5.31; brick, $5.04; stone block, $6.28; macadam, $3.05; concrete, $4.68; oil surfacing, $1.75; gravel, $1.13.[A136*]

Wartime Personnel in Portland Water District

Every person employed by this water department was registered under F.B.I. specifications, photographed and fingerprinted, and furnished with an identification button and an identification card bearing the signature and photograph of the bearer and the seal of the district. The personnel was split into divisions, and each foreman was given charge of several zones, and each zone was represented by at least one workman and two men to aid him. The zoneman's equipment included a canvas knapsack containing a gatebook containing all the measurements of the zone, a 100 ft. tape and a flashlight. Gate wrenches were placed at a convenient location in each zone.

Guards were paid $4.00 a day for 8-hour duty, three shifts a day. They were sworn in as deputy sheriffs and given badges, armed with shotguns loaded with buckshot and placed under the supervision of a hard-boiled captain.[B36*]

Concrete Reservoirs Of the Vertical Beam Type

The construction of covered concrete storage reservoirs with side walls constructed as simple vertical beams supported by the roof and floor, is described. All concrete in contact with the contained water is in compression. Simple methods are offered for minimizing temperature and shrinkage stresses. The walls are poured in sections sufficiently small to avoid excessive shrinkage cracks, and construction joints are kept at a minimum and treated as expansion joints.

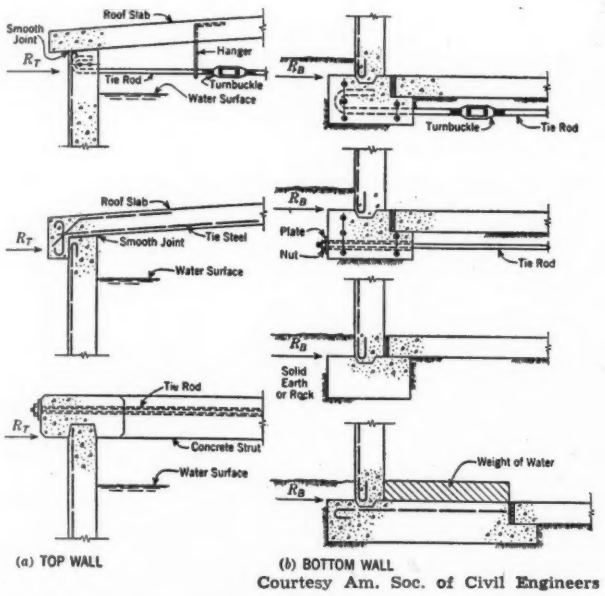
The bottoms of the beams sit in a recess in the footing that permits them to rock slightly. The tops are tied together by the roof slab reinforcing or by tie rods. The main wall reinforcement is vertical and near the outer face. As the top ties expand and contract, the sides can rock on the base. Corners are constructed with expansion joints to permit such rocking. If external pressure from earth exceeds internal pressure, the sides act as cantilevers, still keeping the inner face in compression. Three such reservoirs have been built, of 3,000,000, 120,000 and 100,000 gallons capacity.[K1]

Summer Colony Waterworks Practices

At Monument Beach, Mass., 60% of the consumers are in residence during summers only. Meters are removed from most of the summer cottages in the fall and stored during the winter. Owners of such cottages are billed for the entire year in advance on Jan. 1st, and if the bill is not paid by July 1st the water is cut off. All-year residents are billed quarterly. Services are generally installed by pushing the pipe under the highway (the soil is sandy), using an air compressor.[G44*]

Use of Chemicals In Canada in 1941

Of 217 waterworks in Canada, 92 used chlorine only in 1941 and 39 used alum and chlorine only. Aluminum sulphate used in the granular form totaled 3,260 tons; in the lump form, 1,082 tons, and in slab form 421 tons. Of lime, 2,568 tons was used; of chlorine, 751 tons; of salt, 500 tons (by one plant); of soda ash 524 tons; of sulphur dioxide, 105 tons; of ammonium sulphate, 66.5



Courtesy Am. Soc. of Civil Engineers

Methods of supporting wall of vertical beam reservoirs.

*See Bibliography in the December issue.

tons; of activated carbon, 33.2 tons; of chloride of lime, 32.6 tons; of sodium silicate, 13.2 tons (one plant only); of copper sulphate, 5.5 tons; of caustic soda, 11.4 tons; of anhydrous ammonia, 4.1 tons; of sodium aluminate, 1.2 tons; of H.T.H., 1.6 tons; of sulphate of iron, 2 tons. A total of 9,383 tons.[M29]

Wartime Contamination

Contamination of water supplies from the air is highly improbable. Saboteurs can do little harm with chemicals or gases, and that only with difficulty. They may be able to make some people sick, perhaps kill a few. But the risk of this to any individual is less than that of being hit by an automobile or of a common household accident.[X1]

Odor Control At Beaver Falls, Pa.

Beaver Falls takes its supply from the Beaver River, which is highly polluted with phenols. It has used activated carbon for odor control since 1931, the rate in pounds per m.g. increasing from 10.1 in 1932 to 68.3 in 1937, 134 in 1938 (when phenol became intense), 198.6 in 1940 and 122.4 in 1941. Contrary to some experiences, the alum dosage had to be increased with the carbon, averaging 1.02 gpg. prior to 1932, 1.9 from 1932 to 1937, and 1.70 from 1938 to 1941, every peak in monthly averages of carbon showing a corresponding peak in alum. To prevent carbon passing the filter, alum is added directly to a filter while it is being refilled after being washed. Infiltration of carbon into the sand bed is less where air wash is used, and is prevented by use of Palmer agitators.

Experiments in 1938-40 to try to reduce cost of odor control, using aeration, super-chlorination, potassium permanganate, bleaching clay, ozone, and storage, with the advice of John R. Baylis, led to continuation of use of activated carbon under routine control. At least once a day threshold tests are run on raw water, on water after coagulant and carbon have been added, and on the filter effluent, making at least six dilutions for each test.

Whenever the water temperature drops below 40° the carbon dosage has to be increased very markedly, probably because of the effect of the biological activity of the stream on the phenolic compounds. When the river is frozen over, even the maximum amounts of carbon will not completely remove the odors.[X3]

Odor Control At New Castle, Pa.

Ammonia applied a considerable time ahead of chlorine slightly improved the odor but when applied only a foot ahead there was an immediate increase of 0.30 ppm in chlorine residual. It is used all the time in the filtered water; also in raw water when odor or algae conditions are bad. It is very effective with odors from decomposing vegetable matters or settling basin sludge. Carbon is very effective with some odors and in stabilizing settling basin sludge; it is used to control chemical, hydrocarbon and medicinal odors, in doses of 0.1 to 1.0 gpg, averaging 0.2. Ammonia-chlorine is used for musty, septic, sulfuretted and decomposition odors, in doses averaging 0.25 ppm ammonia and 1.25 ppm chlorine.[X4]

Water Softening At St. Paul, Minn.

St. Paul's water softening plant, constructed in 1939-'40, with a capacity of 90 mgd, includes a flocculator, two circular tank clarifiers, a recarbonation chamber, and the mechanical softening equipment. The flocculator basin

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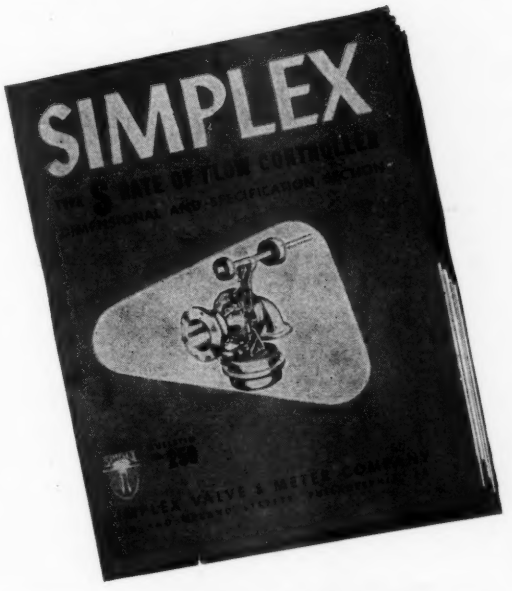

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is 46 x 140 ft. by 20 ft deep, equipped with five sets of paddle wheels, each driven by an independent motor at one of 4 speeds. Approximately 8½ billion gal. of water is treated annually.

Water from the Mississippi 15 miles above St. Paul passes through a chain of three lakes with a combined capacity of 7 billion gal., which reduces the bacterial population, color and turbidity but greatly increases the micro-organisms, the gains of storage slightly outweighing the losses. The average hardness is 176 ppm of which 27 is permanent. In softening, 107.5 ppm of milk of lime is added, mixed by air from a bottom manifold at the rate of 6,000 cu. ft. per mg, which also oxidizes the water and removes the dissolved gases. Then 8.8 ppm of alum is added, and mixing and flocculation continued for 60 min. and sedimentation for 4 hr. Then CO_2 gas is added at the rate of 3,600 cu. ft. per mg. Before filtration, 0.16 ppm of ammonium sulfate and 0.092 ppm of phosphorous are added, and 0.81 ppm of chlorine immediately after filtration. The CO_2 is obtained from the boiler stack, drawn from the boiler breeching by a 1,000 cu. ft. compressor, first passing through a scrubber. To remove the fly ash, a cyclone ash remover and glass fiber filter were used, but have been replaced with a plenum chamber 7 x 7 x 40 ft. long. Dryers are being built into the discharge side of each scrubber. A pH of 9.5 is maintained at the first point of application of the CO_2 in the recarbonation chamber, reduced to 8.5 by a second application in the clear well. Total hardness is reduced to 75-80.

About 50% of the sludge is returned to the mixing chambers; the balance, about 90% water, is pumped to sludge beds 1500 ft. distant, from which about 10,000 tons of calcium and magnesium (dry) are removed annually, some of it used by farmers. Cost of filtering and softening is $13.91 per mg. Softening alone costs about $50,000 per year and saves the consumers $300,000.[L11]

Aeration Of Spillways

The aeration of spillways and measuring weirs has been given too little attention. Insufficient aeration of overfall weirs reduces the pressure beneath the nappe, which increases the pressure on the weir, increases the theoretical flow, and often causes a pulsation of the nappe that creates dynamic pressures on the weir. The author has analyzed all available data to provide a workable criterion for the size of aeration vents required.[K3]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n,* note or short article; *p,* paper before a society (complete or abstract); *t,* technical article.

A *Journal, American Water Works Ass'n*
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1. The Olean, N. Y., Flood in Relation to Mutual Aid and Civilian Protection Programs. By Alan D. Drake and Frank O'B. Nehin, Pp. 1743-1754.
2. Wartime Control of Water Quality. By Charles R. Cox. Pp. 1755-1761.
3. The Value of Distribution System Studies for Meeting Present Emergencies and Post-War Problems. By E. Shaw Cole. Pp. 1762-1766.
4. Preparing the Valve System for Emergency Service. By Alvin J. Kuecker. Pp. 1767-1770.
5. Water Main Cleaning in the War Effort. By Clinton Inglee. Pp. 1771-1776.
6. Sterilization of New and Repaired Mains. By C. H. Billings. Pp. 1777-1781.
7. Control of Chlorination. Committee Report. Pp. 1782-1784.
8. A Modification of the Flash Color Test to Control Break-Point Chlorination. By Paul C. Laux and J. B. Nickel. Pp. 1785-1786.
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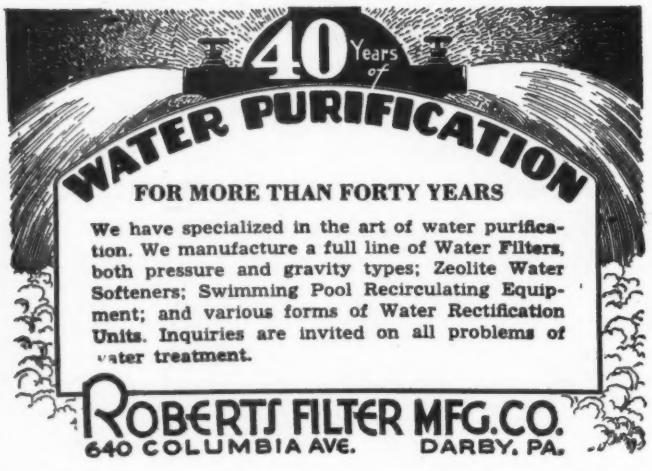
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12. A Summary of Census Data on Water Treatment Plants in the United States. By S. R. Weibel. Pp. 1831-1846.
13. Design and Operation Data on Large Rapid Sand Filtration Plants in the United States and Canada. By Eugene A. Hardin. Pp. 1847-1879.
14. An Operators' Monthly Balance Sheet. By Charles E. Moore. Pp. 1880-1888.
15. Manual on Emergency Repairs to Water Distribution Systems. Pp. 1889-1913.

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1. *p.* Treatment of Water for Domestic and Industrial Purposes. By Albert Parker. Pp. 395-396.

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1. Inventory Is the Chief Current Problem. Editorial. P. 1381.
2. Pump Changes Show Power Savings. By Wm. P. Hughes. Pp. 1382-1384.
3. The Control of Water Waste Within Buildings. By Edward Nuebling. Pp. 1385-1390, 1410.
4. War Influences Water Supply Conditions Near Washington. By Harry R. Hall. Pp. 1403, 1412.

December 2

5. Treating a Troublesome Water (Saginaw, Mich.). By Nathan N. Wolpert. Pp. 1436-1439.
6. Sanitation of the Croton Watershed. By Theodore D. Coffin. Pp. 1440-1442, 1462.

G *Water Works & Sewerage*
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1. Bacteriological Results of Break-Point Chlorination. By Albert E. Wilson, Jr. Pp. 494-495.
2. The Determination of High Chlorine Residuals. By N. S. Chamberlin. Pp. 496-499.

J *American City* L
December

1. The Galveston Plan for Water Supply. Pp. 54-55, 81.
2. Meeting a War-Induced Water Shortage Crisis. Pp. 58-59.

K *Proceedings, Am. Soc. of Civil Engineers*
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1. Concrete Reservoirs of the Vertical Beam Type. By C. Maxwell Stanley, Jr. Pp. 1679-1688.
2. Illinois Water Litigation, 1940-41. By Langdon Pearse. Pp. 1689-1713.
3. *t.* Aeration of Spillways. By G. H. Hickox. Pp. 1777-1796.

L *Civil Engineering*
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P *Public Works*
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2. Eliminating Dead Ends for Fire Protection. By C. E. Harrison. P. 21.
3. *n.* Negligence in Unguarded Excavation. P. 20.
4. Preference Rating Procedure Up to Date. Pp. 32, 45.
5. *n.* Cutting Off Water for Nonpayment of Sewer Charges. P. 41.
6. *n.* Contractor Not Responsible for Treatment Equipment. P. 42.

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2. Taste and Odor Control with Activated Carbon on Waters of Low Odor Concentrations. By R. B. Adams. Pp. 59-64.
3. Taste and Odor Control for Phenols With Activated Carbon. By E. C. Goehring. Pp. 65-73.
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2. Information and Operation Aids. By Wm. B. Schworm. Pp. 9-17.
3. Census of Water Supplies in Missouri. Pp. 27-34.
4. Chemical Analyses of Missouri Water Supplies. Pp. 35-40.

Hydrated Lime in Sewage Treatment

(Continued from page 13)

must be added to be effective in reducing the coagulant demand.

Discussion

Examination of hydrated lime by electro-micrographs indicated the presence of some crystals. A number of the calcite crystals appear to be covered by a layer of extremely fine material. The formation of this layer about the calcite crystals may be a factor when the hydrated lime is poured or rolled in feed machines. Some limes have a greater tendency than

(Continued on page 51)

Remember!

VALVES
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Due to rapidly changing personnel on account of employees going to the Army and Navy, valves and hydrants may now be sometimes in the hands of persons not very familiar with their proper care. We offer the following suggestions:

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others to bridge or arch in feed machines. The formation of those small pellets or ball-like aggregates may also affect the dispersion of lime particles in a liquid and, as a result, affect the rate of solution.

The relation of solubility of hydrated lime to the quantities used indicates that the Franklin lime had the greatest solubility. It is possible that the Franklin lime shows a greater solubility because of it being in a more active state and that the particles were more finely divided than those of other hydrated limes. This is related to the high secondary and tertiary solubility, which in water and sewage treatment is necessary to hold the pH values sufficiently high. Since in sewage treatment hydrated lime in solution is more active and more effective than hydrated lime in suspension, a lime of greater solubility will produce better results.

It appears that the particles of hydrated lime are not thoroughly dispersed during a short time of stirring. In this respect the Franklin lime was poorest. In all cases a layer of calcium carbonate is formed around the hydrated lime particles, preventing their rapid solution and subsequently decreasing their effect on the pH values of the liquid. Upon further stirring, the agglomerated particles may be broken up and dispersed throughout the liquid, resulting in higher pH values. A secondary rise in pH values usually occurred after 15 minutes with the Franklin lime, whereas the other limes required a longer time. This may be an important factor, since in water and sewage treatment practice the time of stirring is normally between 15 and 30 minutes. Carbonation, both in the liquid and in the atmosphere, is greatest at the beginning. Carbonation starts at the surface and proceeds slowly toward the interior of the particle. When hydrated limes form small balls, a layer of carbonate is formed, but the relatively impervious coating prevents further carbonation unless the particles are broken up; hence the rate of carbonation is related to the ball-like structure and the ease with which the aggregates break.

Experiments on the rate of flow of dry hydrated lime when fed through a machine indicate that larger particles flowed more easily than particles of small size. There was a distinct difference between the ease of flow of the +100 mesh material and the −400 mesh particles. Regardless of how fine the particles, they did not form small balls or aggregates formed with the original mixed sizes. Apparently some of the larger particles serve as nuclei for the smaller particles. When some of the hydrated limes were rolled in glass bottles, particles stuck to the sides of the bottles and the lime flowed with difficulty. Rubbing the inside of the bottles with rubber-covered glass rods caused the particles to lose the property of sticking. When a glass rod was rubbed with cloth and held over the surface of the lime, particles were observed to leap up and stick to the rod. Attempts to place a larger electrical charge on the particles, by means of a special discharge electrode, showed this to be possible, but the charge was not particularly stable, the stability depending upon the humidity of the atmosphere.

The turbidities in sewage caused by the several hydrated limes were materially different. Differences in turbidity removal as a result of lime addition were less for Franklin and York limes than for the other two. The removal of suspended lime particles is of interest in sewage treatment where the particles become imbedded in the sludge and may be a factor in the subsequent treatment of sludge. The difference between the various limes tested in sewage was small, probably on account of certain sewage constituents which affect their removal from the liquid. The optimum of transparency of the supernatant liquor is reached with a given dosage, and additional quantities of lime have no value for this purpose.

The effect of lime on sewage clarification varies with the type of lime, the concentration of the lime and the strength and character of the sewage, irrespective of the calcium or magnesium content of the lime. In general, the stronger and staler the sewage, the greater the amount of lime required. Of considerable interest is the effect of lime on the iron or aluminum coagulant demand of sewage. In addition to pH adjustment, the hydrated limes have coagulating power of their own and, perhaps even more important, are capable of removing certain constituents of sewage which interfere with coagulation or have an excessive iron and aluminum coagulant demand. The various limes tested had a definite effect on the volume and compactness of the sludge produced.

Summary

A study was made of the properties, particularly structure, size of particles, solubility, flowing characteristics, and behavior, of commercial high-calcium hydrated limes used in sewage and water treatment. The comparative effect of the hydrated limes was determined on remaining turbidity, clarification, and coagulant demands of sewage.

Commercial high-calcium hydrated limes showed no apparent predominant crystalline structure when examined under a petrographic microscope, but at least one of those examined (Franklin lime) appeared to have a considerable number of fine crystalline particles when electro-micrographs were made with a magnification of 31,000. The solubility in water of Franklin lime was greatest, followed by York, Farnam, and Bellefonte limes. Secondary solubility, destruction of bicarbonate alkalinity, and greater dispersion of particles of the limes were in the same order. When the same quantities of hydrated lime were used, Franklin produced somewhat higher pH values in a shorter time than did the York, Farnam, and Bellefonte limes. The rate of carbonation of the various limes appeared to be the same, the greatest amount of carbonation taking place during the first day's exposure to the atmosphere.

It appears that the relative size and uniformity of lime particles determine their flow characteristics, the larger the particles, the easier is the flow, but fine particles flow more easily than mixtures of large and fine particles. Increase or change of electrical charges also may change the ease of flow.

The finer the particles, the better are the results in sewage clarification, the largest particles producing the poorest results. Best results are obtained with hydrated lime containing very fine, easily dispersed particles, having a large surface.

Hydrated lime reduces materially the iron and aluminum coagulant demand of sewage, increases the clarity of the liquor, and changes the character of the sludge formed.

The above, written for PUBLIC WORKS, is a Journal series paper of the New Jersey Agricultural Experiment Station, Rutgers University, Dept. Water and Sewage Research. Work conducted under a fellowship grant by the Limestone Products Corporation of America.

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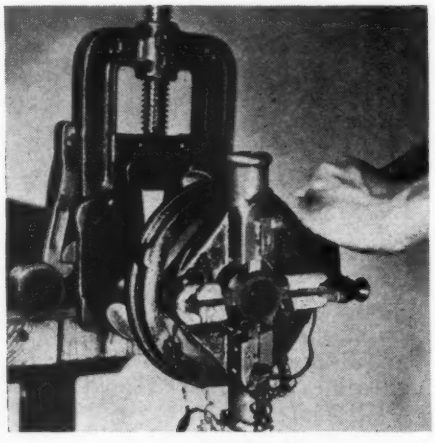

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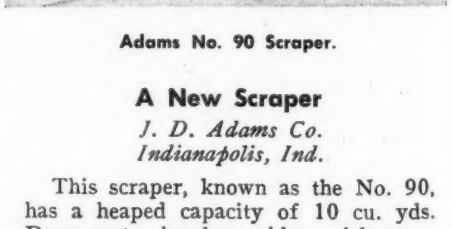
9 Codding St., Providence, R. I.

This device enables establishing any selected rate of flow through the mains. With it the sterilizer can be adjusted for the proper rate of speed at the water laboratory or shop while the actual dosing of the main can be done by non-technical personnel. It consists of a tube with a National Standard hydrant coupling at one end, a replaceable fixed orifice or mouthpiece of a simple design at the other end, and a direct reading gauge for indicating the flow rate in gallons per minute. It converts main sterilization from a complicated process to a simple procedure easily and efficiently followed by any work crew. It is simple, inexpensive, compact and of rugged construction. Write Proportioneers for full information.



Adams No. 90 Scraper.

A New Scraper

J. D. Adams Co.
Indianapolis, Ind.

This scraper, known as the No. 90, has a heaped capacity of 10 cu. yds. Drop center bowl provides quick penetration and balanced loading while four large low pressure tires, over which the weight is evenly distributed, provide for easy hauling and plenty of flotation

in soft material. A 70 degree dumping angle insures free discharge of material which can be spread evenly to any desired depth.

Frame is all-welded, box-type construction with full oscillating front axle and tongue. All cables are in line down the center of the bowl and operation is easy and positive in action. Operation is through an Adams No. 20 Power Control Unit or any standard 2-drum hoist connected to the power take-off of the tractor.

For complete information and specifications write J. D. Adams Co.

William C. Carter Elected President of Link-Belt Company

He succeeds Alfred Kauffmann who resigned because of ill health. In tendering his resignation Mr. Kauffmann stated, "After having given the company 41 years of service, I feel that I have earned a release from the exacting duties of chief executive."

Mr. Carter is a chemical engineering graduate of the University of Illinois. He entered the employ of the Link-Belt Company in 1902 as a draftsman. On the way to the top executive of the company, he has been engineering department supervisor, construction superintendent, plant superintendent, plant general manager, vice president in charge of production and executive vice president in complete charge of company affairs since Mr. Kauffmann's illness.

Jeff Corydon Resigns as President of %Proportioneers, Inc.% New Officers Elected

Effective December 11, 1942, Jeff Corydon resigned as President and Director of %Proportioneers, Inc.%., Providence, R. I.

All company matters should be referred to %Proportioneers% as he is *severing all active connection with the company,* except for stockholdings still retained.

Mr. Corydon will continue at the same residential address indefinitely and at %Proportioneers% office address for the time being. His future plans will be announced in due time.

The new officials of %Proportioneers, Inc.% are: R. P. Lowe, President; H. E. Hollberg, Vice President; H. S. Chafee, Treasurer; E. A. Bradley, Secretary.

Army-Navy "E" Awards

Osgood Company
Marion, Ohio

On September 8, 1942 Robert P. Patterson, Under Secretary of War, wrote the Osgood Company as follows:

"This is to inform you that the Army and Navy are conferring upon you the Army-Navy Production Award for your fine record in the production of war equipment.

"The award consists of a flag to be flown above your plant, and a lapel pin which every man and woman in your plant may wear as a symbol of high contribution to American freedom

"This award is your nation's tribute to your patriotism and to your great work in backing up our soldiers on the fighting fronts. I have full confidence that your present high achievement is indicative of what you will do in the future."

Goodyear Tire & Rubber Co.
Akron, Ohio

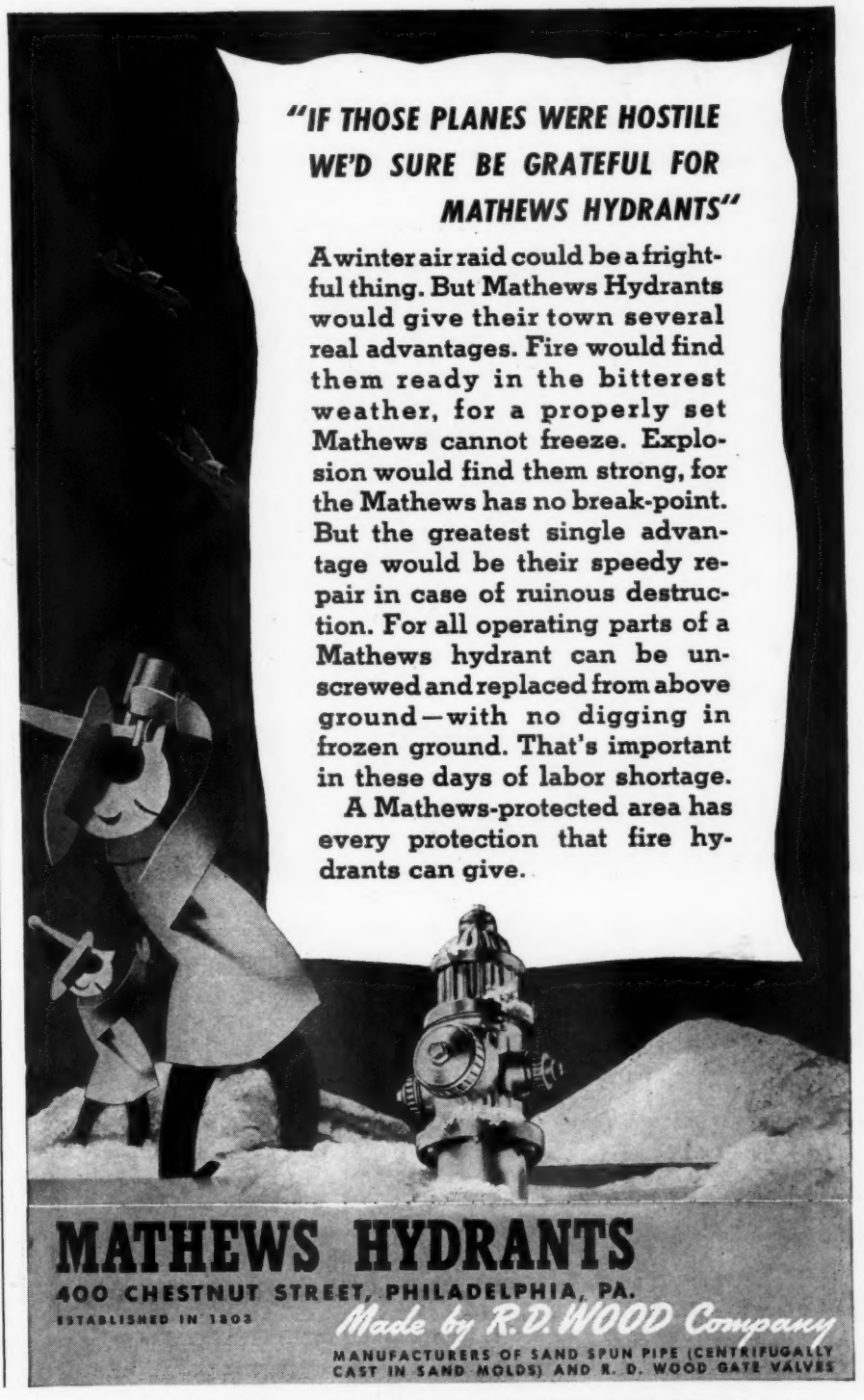
Major W. B. McClelland of Cleveland and Lieutenant R. M. Stocking of Lima, Ohio, represented the United States Army and Navy on January 6 when an "E" flag was presented to the St. Marys Manufacturing Company, a Goodyear subsidiary.

Major McClelland, chief of the Cleveland Ordnance District's automotive section, awarded the flag itself while Lieutenant Stocking presented token "E" lapel pins to A. A. Teisher, general superintendent of the St. Marys Plant, and A. W. Kellermeyer, president of the St. Marys plant's union.

Pins were distributed subsequently to all the plant's employes.

The flag was accepted on behalf of the company by Teisher and E. J. Thomas, president of the St. Marys Manufacturing Company.

Others who took part in the program in the high school auditorium on January 6 include Mayor Albert M. Koch; the Reverend George P. Kehl and the Reverend Father John J. Brinker and many Goodyear officials.


"IF THOSE PLANES WERE HOSTILE WE'D SURE BE GRATEFUL FOR MATHEWS HYDRANTS"
A winter air raid could be a frightful thing. But Mathews Hydrants would give their town several real advantages. Fire would find them ready in the bitterest weather, for a properly set Mathews cannot freeze. Explosion would find them strong, for the Mathews has no break-point. But the greatest single advantage would be their speedy repair in case of ruinous destruction. For all operating parts of a Mathews hydrant can be unscrewed and replaced from above ground—with no digging in frozen ground. That's important in these days of labor shortage.
A Mathews-protected area has every protection that fire hydrants can give.
MATHEWS HYDRANTS
400 CHESTNUT STREET, PHILADELPHIA, PA.
ESTABLISHED IN 1803
Made by R.D. WOOD Company
MANUFACTURERS OF SAND SPUN PIPE (CENTRIFUGALLY CAST IN SAND MOLDS) AND R. D. WOOD GATE VALVES

When you need special information—consult the classified READER'S SERVICE DEPT., *pages 55-57*

Forest Industry Tells Story of Its War Effort in Pictures

Published by the Timber Engineering Company, Washington, D. C., is *The Forest Fights*, a book of news pictures showing the jobs the forest industries have done and are doing to forward the nation's war effort.

It contains some 200 photographs, with brief descriptive copy. The 48-page book takes the reader from action shots "at the front" through the supply line and training camps, to industry and war housing on "the home front".

In all the pictures wood is shown in some war use, major or minor. Other chapters show uncommon or revived uses of wood, improved engineering methods in timber, research that is developing broader uses for wood.

Scrap and How to Collect It

American Salvage Committee
Empire State Bldg., New York City

Donald M. Nelson says, "We are faced with a serious shortage of steel scrap, rubber and other vital materials. That shortage must be filled." The booklet describes what scrap is, itemizes the products needed, and tells where to look for them. This booklet will be of great aid to local salvage committees in figuring the maximum of scrap from their communities. Write for a copy.

Water Production for Municipal and Industrial Use

Ranney Water Collector Co. of N. Y.
Heyburn Bldg., Louisville, Ky.

This 26-page booklet describes and illustrates the underlying principles of the Ranney method of extracting water from the ground or by infiltration through permeable beds of rivers or other bodies of water.

It is claimed that because of the features and because the horizontal collecting pipes are located for the entire length below the draw-down level of the ground water, Ranney Units can be used to develop a water supply at a particular site of a quality and quantity that may not be economically obtainable by conventional methods. One of the chapters is headed, "Collectors As Ground Water Producing Units"; another, "Collectors As Infiltration Units"; and another, "Performance Chart".

Complete information is given as to how the Ranney method operates and under what conditions it has proven a successful method of producing ample and satisfactory water supply. It is an interesting booklet for those concerned with municipal and industrial water supply. Copies are available upon request.

Wrought Iron for Underground Services

A. M. Byers Co.
Pittsburgh, Pa.

A colorful and easy-to-read new technical bulletin has just been released by the Engineering Service Department of A. M. Byers Company, Pittsburgh.

Designed to be of service to municipal water works engineers. The new booklet discusses the most important factors affecting soil corrosion of underground piping, weighs theory against test results and outlines installation histories of water wells, and lines, lawn sprinkler piping.

It includes many photographs of underground piping installations under varied conditions in major cities throughout all parts of the country.

Surveying Instruments and Drafting Supplies

Warren-Knight Company
139 North 12th St., Philadelphia, Pa.

It describes and illustrates a complete line of surveying instruments and drafting supplies and a new weight slide rule which is of value to those working in metals. The factory of this company is working almost 100% on Government orders but at infrequent intervals they can work on their regular line of instruments and have most of the models in production and are making delivery promises of from 4 weeks to 6 months depending somewhat on the models required. Copies of the booklet are available upon request.

Roots-Connersville Positive Displacement Blowers operate at varying pressure without loss of volumetric efficiency. They offer economical, efficient, and simple means of aerating sludge, when direct-coupled to sludge gas engines, as engine speed is easily varied to suit the air demands of varying sewage flows.

Priorities may prevent your obtaining equipment now, but there's no priority on our furnishing facts regarding "R-C" equipment for your future needs. Write for Bulletin 23-B12.

ROOTS-CONNERSVILLE BLOWER CORPORATION
301 VALLEY AVENUE, CONNERSVILLE, IND.

Two "R-C" Aerating Blowers direct connected to sludge gas engine at Sioux Falls, S. D.

All Out for VICTORY

Roots CONNERSVILLE SINCE 1854 Aerating BLOWERS

INCINERATION ENGINEERS
NICHOLS ENGINEERING & RESEARCH CORPORATION
60 WALL TOWER NEW YORK, N. Y.
Consultants • Designers • Constructors

When writing, we will appreciate your mentioning **PUBLIC WORKS**

Readers' Service Department

These booklets are FREE but distribution is restricted to those actively engaged in engineering or construction. Use the coupon below or write the manufacturer direct, mentioning PUBLIC WORKS.

Construction Materials and Equipment

Air Raid Shelters

3. New 8 page booklet pictures and describes a corrugated pipe shelter with gas tight end walls, emergency escape tunnel and other desirable features. Armco Drainage Products Assn., Middletown, Ohio.

Asphaltic Limestone

5. Characteristics, methods of laying, and results with cold lay mixture shipped ready to use. Especially adapted to resurfacing old pavements, sealcoats and airport runways. Alabama Asphaltic Limestone Co., Liberty Nat. Life Bldg., Birmingham, Ala.

Bridges

7. Teco Connectors, a new method of structural engineering, to spread the load on a timber joint more equally over the cross-section of the wood is described in new literature available from Timber Engineering Co., Inc., Dept. BS-2, 1319—18th St., N. W., Washington, D. C.

Cement Dispersion

9. "Economics of Cement Dispersion and Pozzolith" tells the complete story of how cement dispersion reduces water required up to 20% and increases workability 150%. Write The Master Builders Co., Cleveland, Ohio, for a copy.

10. A valuable treatise on available means of securing high strength, prevention of sealing, increased durability and improved wear resistance in concrete pavement construction. Master Builders Co., 7016 Euclid Ave., Cleveland, Ohio.

Cement, Early Strength

11. 64-page manual tells how to speed up year 'round concreting, shows how to secure high early strength and greater workability at temperatures either below or above freezing. Contains many actual examples of practical concreting operations; well illustrated with more than 60 photos, charts, graphs and tables. Calcium Chloride Assn., Penobscot Building, Detroit, Mich.

Cold Mix Plants

15. New catalog and prices of Portable Bituminous Mixers in 6 to 14 ft. sizes for resurfacing and maintenance. Issued by The Jaeger Machine Co., 400 Dublin Ave., Columbus, Ohio.

Concrete Accelerators

31. New 48-page booklet in five sections explains clearly the effects, advantages and methods of using Calcium Chloride and Portland Cement mixes. Complete and packed with practical information; well illustrated; pocket size. Sent free on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Concrete Curing

32. Tru-Cure, a newly developed compound for curing concrete, is a clear liquid that is sprayed on wet concrete immediately after finishing. Saves several hours to a day's time usually lost on the average concrete job. Write for literature and full details. Truscon Laboratories, Detroit, Mich.

33. Pocket manual of concrete curing with calcium chloride. Complete, handy. Contains useful tables, well illustrated. Write the Columbia Chemical Division, Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa.

Concrete

36. "Cutting Concrete Costs"—Booklet analyzes costs and outlines methods of figuring the lowest cost schedule. Notes on job planning. For copy, write Lone Star Cement Corp., 342 Madison Ave., New York, N. Y.

Concrete Mixers

44. Catalog and prices of Concrete Mixers, both Tilting and Non-Tilt types, from 3½S to 56S sizes. The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Drainage Products

70. Standard corrugated pipe, perforated pipe and MULTI PLATE pipe and arches — for culverts, sewers, subdrains, cattlepasses and other uses are described in a 48-page catalog entitled "ARMCO Drainage Products," issued by the Armco Drainage Products Association, Middletown, Ohio, and its associated member companies. Ask for Catalog No. 12.

Drainage

71. Walker Poroswall Rapid Drain Pipe for Drainage or Water Collection is claimed to be the fastest drainage medium known. Send for latest literature explaining its many uses. Walker Cement Products Co., Little Ferry, N. J.

73. "Principles of Design of Airport Drainage" and other articles on airport drainage reprinted from PUBLIC WORKS Magazine are being distributed free by Bowerston Shale Co., Bowerston, O., Hancock Brick & Tile Co., Findlay, O., and Columbus Clay Mfg. Co., Blacklick, O. Address anyone of the above for a copy.

Graders, Patrol

105. The Austin-Western 99M Power Grader with its powerful all wheel drive simplifies all construction and maintenance; handles difficult jobs with economy and efficiency; and does better work on grading, ditching, scarifying, snow plowing, loading, mixing, bulldozing, shoulder trenching and backsloping. Write for Bulletin 1946. Austin-Western Road Machinery Co., Aurora, Ill.

Mud-Jack Method

107. How the Mud Jack Method for raising concrete curb, gutter, walls and street solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities — a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee, Wis.

Oil

109. Ring-Free Motor Oil that keeps motors clean and free from carbon, and reduces frequency of overhauls is described in literature available from Macmillan Petroleum Corp., 530 West 6th St., Los Angeles, Calif.

Paving Materials, Bituminous

111. New "Tarvia Manual" is packed with useful data on how to build and maintain roads with Tarvia. Each step is illustrated with excellent action pictures, 64 pp. 103 ills. Write to The Barrett Div., 40 Rector St., New York, N. Y.

Pumps

120. Interesting new booklet tells how to lengthen the life of your pumps. Explains how a little care will save a lot of wear. Write today for your copy. Homelite Corp., 2403 Riverdale Ave., Portchester, N. Y.

121. New illustrated catalog and prices of Jaeger Sure Prime Pumps, 2" to 10" sizes, 7000 to 220,000 G.P.H. capacities, also Jetting, Caisson, Road Pumps, recently issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

123. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

124. 16-page illustrated bulletin, SP-37, describes and illustrates complete C. H. & E. line of self-priming centrifugal pumps from ½" to 8", including lightweight models for easy portability. C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee, Wis.

Road Building and Maintenance

128. Motor Patrol Graders for road maintenance, road widening and road building, a complete line offering choice of weight, power, final drive and special equipment to exactly fit the job. Action pictures and full details are in catalogs Nos. 253, 254 & 255, issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

Rock Drill Maintenance

130. New booklet presents through amusing cartoons useful hints on proper rock drill maintenance methods—what your men can do to get more work out of your tools with a minimum of expense for repairs and compressed air. Write The Cleveland Rock Drill Co., 3734 East 78th St., Cleveland, Ohio.

Rollers

133. New Tu-Ton roller of simple construction for use in rolling sidewalks along highways, playgrounds and other types of light rolling is fully described in a bulletin issued by C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee, Wis.

138. "The Buffalo-Springfield line of road rollers (tandem, 3-wheel, and 3-axle) are described in the latest catalog issued by the Buffalo-Springfield Roller Co., Springfield, Ohio."

139. "Ironeroller" 3 Axle Roller for extra smooth surfaces on all bituminous work. Booklet contains roller data and operation details. Hercules Co., Marion, Ohio.

140. This well-illustrated 16-page catalog describes the tandem, autocrat, cadet, and roll-a-plane rollers, and explains what each is intended to accomplish. Write Austin-Western Road Mach. Co., Aurora, Ill.

Rotproofing

145. Cuprinol, a rotproofing chemical that protects wood from fungi and insects, yet has no offensive odor, is non-poisonous, does not corrode metal and can be painted over. Get full details in booklet from Cuprinol, Inc., 7 Water St., Boston, Mass.

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Please send me without obligation the following booklets listed in your READERS' SERVICE SECTION .....
(indicate by numbers)

Name .....

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Soil Stabilization

150. "High-Service, Low Cost Roads" is one of the newer booklets using an effective combination of picture and text to set forth the principles and advantages of road surface stabilization with calcium chloride. Complete, interesting and well illustrated. 34 pages. Sent by Solvay Sales Corp., 40 Rector St., New York, N. Y.

152. The Columbia Chemical Division will be glad to furnish to anyone interested complete information dealing with Calcium Chloride Stabilized Roads. This literature contains many charts, tables and useful information and can be obtained by writing Columbia Chemical Div., Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa.

154. "Soil Stabilization with Tarvia"—An illustrated booklet describing The steps in the stabilization of roadway soil with Tarvia will be mailed on request by The Barrett Div., 40 Rector St., New York, N. Y.

Spreader

187. Jaeger Paving equipment, including Mix-in-Place Roadbuilders, Bituminous Pavers, Concrete Bituminous Finishers, Adjustable Spreaders, Forms, etc.—4 complete catalogs of latest equipment in one cover, issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Surface Consolidation and Maintenance

188. Detailed and illustrated presentation of the method and procedure in consolidated operations; explains how sub-soils can be conditioned to resist softening and frost action; how surfacing can be consolidated to provide smooth all-weather riding surfaces; how they can be maintained so as to prevent disintegration and gravel loss. Write the Calcium Chloride Association, Penobscot Bldg., Detroit, Mich., for Bulletin No. 29.

Timber Structures

189. "Typical Designs of Timber Structures" contains plans for 45 representative structures that have been engineered with Teco Connectors. For free copy write Timber Engineering Co., Inc., Room 6GG, 1319—18th St., N. W., Washington, D. C.

Street and Paving Maintenance

190. "Blacktop Road Maintenance and Construction Equipment"—Asphalt and tar kettles, flue type kettles, spray attachments with completely submerged pumps, tool heaters, surface heaters, road brooms, portable trail-o-rollers, etc. Tnese are all described in detail and illustrated. This modern and up-to-date equipment for blacktop airport and road construction and maintenance is based upon experience and engineering research over a period of 42 years. Write for Catalog R. Littleford Bros., Inc., 452 East Pearl St., Cincinnati, O.

Snow Fighting

Snow Plows

350. "Frink One-Way Sno-Plows" is a four page catalog illustrating and describing 5 models of One-Way Blade Type Sno-Plows for motor trucks from 1½ up to 8 tons capacity. Interchangeable with V Sno-Plow. Features, specifications and method of attaching. Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

Ice Control

351. "Make Icy Highways Safe for Traffic"—a new bulletin by Michigan Alkali Co., Wyandotte, Mich., tells how to use calcium chloride for modern ice control.

Sanitary Engineering

Aero-Filter

356. "Results Produced by Aero-Filters" is a new pamphlet covering results at Temple, Texas; Paris, Ill.; Webster City, Iowa; and Mason, Mich. Write Lakeside Engineering Corp., 222 West Adams St., Chicago, Ill.

Air Release Valves

357. Automatic Air Release Valves for water, sewage and industrial uses are described and illustrated in new catalog issued by Simplex Valve & Meter Co., 6750 Upland St., Philadelphia, Pa.

Analysis of Water

360. "Methods of Analyzing Water for Municipal and Industrial Use" is an excellent 94 page booklet with many useful tables and formulas. Sent on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Activation and Aeration

376. A valuable booklet on porous diffuser plates and tubes for sewage treatment plants. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability. 20 pp. illustrated. Sent on request to Norton Company, Worcester, Mass.

Blowers

379. All interested in low cost air for sewage disposal will want a copy of this catalog describing operating principles and specifications of Roots-Connersville Aerating Blowers. Write to Roots-Connersville Blower Corp., 301 Valley Ave., Connersville, Ind.

Chlorinators, Portable

380. Complete data on new portable chlorinator designed to meet emergency calls quickly and efficiently. Write Wallace & Tiernan Co., Inc., Newark, N. J.

381. "Emergency Sterilization Equipment," a new bulletin describing the advantages of Dual Drive Chlor-O-Feeders which can serve as either a permanent chemical feeder or as a portable emergency chlorinator. Order from Proportioneers, Inc., 96 Codding St., Providence, R. I.

Cleaning Sewers With Own Forces

383. A 20-page booklet describes and illustrates a full line of sewer cleaning equipment—Rods, Root Cutters, Buckets, Nozzles and Flushers. Write W. H. Stewart (Pioneer Mfr. since 1901), Jacksonville, Fla., or P. O. Box 767, Syracuse, N. Y.

Consulting Engineers

385. "Who, What, Why" outlines briefly the functions of the consulting chemist and chemical engineer. Covers various methods of cooperation, on different types of problems, with industry, with attorneys and with individuals. Foster D. Snell, Inc., 305 Washington St., Brooklyn, N. Y., will send a copy on request.

Feeders, Chlorine, Amonia and Chemical

387. For chlorinating water supplies, sewage plants, swimming pools and feeding practically any chemical used in sanitation treatment of water and sewage. Flow of water controls dosage of chemical; reagent feed is immediately adjustable. Starts and stops automatically. Literature from % Proportioneers, Inc. % 96 Codding St., Providence, R. I.

Fire Hydrants

390. Specifications for standard AWWA fire hydrants with helpful instructions for ordering, installing, repairing, lengthening and using. Issued by M & H Valve & Fittings Co., Anniston, Ala.

391. See listing No. 410.

Flow Meters

392. The primary devices for flow measurement—the orifice, the pilot tube, the venturi meter and others—and the application to them of the Simplex meter are described in a useful 24-page booklet (42A). Simplex Valve and Meter Co., 6750 Upland St., Philadelphia, Pa.

Gas Holders and Digesters

393. Clarifiers, sludge digesters and other tanks and gas holders for sludge gas. Graver Tank & Mfg. Co., Inc., East Chicago, Ind.

Gates, Valves, Hydrants

394. Gate, flap and check valves; floor stands and fittings. New catalog No. 34 gives detail information with dimensions for all types of new full line. M. & H. Valve & Fittings Co., Anniston, Ala.

395. Complete booklet with much worthwhile water works data describes fully Ludlow hydrants and valves. Sent on request. Ludlow Valve Mfg. Co., Troy, N. Y.

396. See listing No. 410.

Gauges

398. The full line of Simplex gauges for filtration plants are illustrated and described in catalog issued by Simplex Valve and Meter Co., 6750 Upland St., Philadelphia, Pa.

Laboratory Equipment

403. pH and Chlorine Control. A discussion of pH control and description of comparators, chlorimeters and similar devices. An 80-page booklet. W. A. Taylor & Co., 7301 York Road, Baltimore, Md.

Maintenance

404. "The Lubriplate Way" contains much valuable information on long-lasting Lubriplate lubricants which are especially adapted for difficult conditions such as parts that are immersed in sewage, water or steam. Write Lubriplate Division of Fiske Brothers Refining Co., 129 Lockwood St., Newark, N. J.

Manhole Covers and Inlets

405. Street, sewer and water castings in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., Lafayette Boul. and Indiana Ave., South Bend, Ind.

Meters, Venturi

406. New bulletin illustrates Builders Air Relay system of transmission for the Venturi Meter which is particularly useful for liquids containing suspended solids like sewage. Eliminates corroson, clogged pipes, etc. Write Builders-Providence, Inc., Codding St., Providence, R. I.

Pipe, Cast Iron

408. Handbook of Universal Cast Iron Pipe and Fittings, pocket size, 104 pages, illustrated, including 14 pages of useful reference tables and data. Sent by The Central Foundry Co., 386 Fourth Ave., New York, N. Y.

409. Cast iron pipe and fittings for water, gas, sewer and industrial service. Super-deLavaud centrifugally-cast and pit-cast pipe. Bell-and-spigot, U. S. Joint, flanged or flexible joints can be furnished to suit requirements. Write U. S. Pipe and Foundry Co., Burlington, N. J.

410. "Cast Iron Pipe and Fittings" is a well illustrated 44 page catalog giving full specifications for their complete line of Sand Spun Centrifugal Pipe, Fire Hydrants, Gate Valves, Special Castings, etc. Will be sent promptly by R. D. Wood Co., 400 Chestnut St., Philadelphia, Pa.

Pipe, Transite

414. Two new illustrated booklets, "Transite Pressure Pipe" and "Transite Sewer Pipe" deal with methods of cutting costs of installation and maintenance of pipe lines and summarize advantages resulting from use of Transite pipes. Sent promptly by Johns-Manville Corp., 22 East 40th St., New York, N. Y.

Pipe, 2-inch Cast Iron

417. Generously illustrated booklet describes McWane 2-inch cast iron pipe and its manufacture in streamlined pipe shop. Write McWane Cast Iron Pipe Co., Birmingham, Ala.

Pumps and Well Water Systems

420. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for descriptive booklets. Advertising Dept., Layne & Bowler, Inc., Box 186, Hollywood Station, Memphis, Tenn.

Meter Setting and Testing

430. The most complete catalog we have seen on setting and testing equipment for water meters—exquisitely printed and illustrated 48-page booklet you should have a copy of. Ask Ford Meter Box Co., Wabash, Ind.

Reservoirs, Concrete

431. Data on how large reservoirs may be built at a saving as units by the Wm. S. Hewett System of reinforced concrete construction will be sent without obligation. The Wm. S. Hewett System, 20 N. Wacker Dr., Chicago, Ill.

Screens

434. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straightline Bar Screens" (Vertical and Inclined types). Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.

Sludge Drying and Incineration

440. "Disposal of Municipal Refuse." Complete specifications and description including suggested form of proposal; form of guarantees; statements and approval sheet for comparing bids with diagramatic outline of various plant designs. 48 pages. Address: Morse Boulger Destructor Co., 216-P East 45th St., New York, N. Y.

442. Recuperator tubes made from Silicon Carbide and "Fireclay" Corebusters for maximum efficiency are described and illustrated in bulletin No. 11 issued by Fitch Recuperator Co., Plainfield National Bank Bldg., Plainfield, N. J.

443. Nichols Herreshoff incinerator for complete disposal of sewage solids and industrial wastes—a new booklet illustrates and explains how this Nichols incinerator works. Pictures recent installations. Write Nichols Engineering and Research Corp., 60 Wall Tower, New York, N. Y.

Softening

444. This folder explains the process of Zeolite water softening and describes and illustrates the full line of equipment for that purpose made by the Graver Tank & Mfg. Co., 4809-15 Tod Ave., East Chicago, Ind. Write for a copy of this instructive folder.

Sprinkling Filters

445. Design data on sprinkling filters of Separate Nozzle Field and Common Nozzle Field design as well as complete data on single and twin dosing tanks, and the various siphons used in them, for apportioning sewage to nozzles. Many time-saving charts and tables. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

Swimming Pools

446. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

Taste and Odor Control

449. "Taste and Odor Control in Water Purification" is an excellent 92-page, illustrated booklet covering sources of taste and odor pollution in water supplies and outlining the various methods of treatment now in use. Every water works department should have a copy. Write Industrial Chemical Sales Div., 230 Park Ave., New York, N. Y.

450. Technical pub. No. 207 issued by Wallace & Tiernan Co., Inc., Newark, N. J., describes in detail taste and odor control of water with BREAK-POINT Chlorination, a method of discovering the point at which many causes of taste may be removed by chlorination with little or no increase in residual chlorine. Sent free to any operator requesting it.

Treatment

453. "Safe Sanitation for a Nation," an interesting booklet containing thumbnail descriptions of the different pieces of P.F.T. equipment for sewage treatment. Includes photos of various installations and complete list of literature available from this company. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

454. A full line of equipment for sewage disposal including clarifiers, chemical treatment plants, rotary distributors, gas holders and many other pieces of equipment are described in a new bulletin just issued by Graver Tank & Mfg. Co., 4809-15 Tod Ave., East Chicago, Ind.

455. New booklet (No. 1642 on Link-Belt Circuline Collectors for Settling Tanks contains excellent pictures; drawings of installations, sanitary engineering data and design details. Link-Belt Company, 2045 W. Hunting Park Ave., Philadelphia.

456. New 16-page illustrated catalog No. 1742 on Straightline Collectors for the efficient, continuous removal of sludge from rectangular tanks at sewerage and water plants. Contains layout drawings, installation pictures, and capacity tables. Address Link-Belt Co., 2045 West Hunting Park Ave., Philadelphia, Pa.

457. New illustrated folder (1942) on Straightline apparatus for the removal and washing of grit and detritus from rectangular grit chambers. Address: Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.

458. "Sedimentation with Dorr Clarifiers" is a complete 36-page illustrated catalog with useful design data. Ask The Dorr Company, 570 Lexington Ave., New York, N. Y.

459. A combination mechanical clarifier and mechanical digester, The Dorr Clarigester, is explained and illustrated in a bulletin issued by The Dorr Company, 570 Lexington Ave., New York, N. Y.

461. Preflocculation without chemicals with the Dorrco Clariflocculator in a single structure is the subject of a new booklet issued by The Dorr Company, 570 Lexington Ave., New York, N. Y.

462. Dorrco Monorake for existing rectangular sedimentation tanks, open or closed, is described and illustrated in a new catalog sent on request. The Dorr Co., 570 Lexington Ave., New York, N. Y.

465. Grit Washers and Collectors, by Jeffrey are built in three types: scraper, V-bucket and combination. For full details ask for Jeffrey Catalog No. 703-A. Jeffrey Mfg. Co., 948-99 No. Fourth St., Columbus, Ohio.

466. Flocculation with Floctrols. For details on controlled flocculation, tapered mixing, practical elimination of short circuiting, rapid settling of properly flocculated solds write for Catalog No. 703-A. Jeffrey Mfg. Co., 948-99 No. Fourth St., Columbus, Ohio.

Underdrains, Trickling Filter

468. Illustrated bulletin describes the Natco Unifilter block of glazed, hard burned clay for underdraining filter beds. Write National Fireproofing Corp., Pittsburgh, Pa., for free copy.

Valves (See Gates, Air Release, etc.)

Waste Elimination

469. Full information on the Pitometer Survey—a complete check-up on your water plant to reveal hidden sources of waste—will be sent promptly by The Pitometer Co., 48 Church St., New York, N. Y.

Water Treatment

470. If you have a water conditioning problem of any kind, write Graver Tank & Mfg. Co., Inc., 4809—15 Tod Ave., East Chicago, Ind., who manufacture all types of conditioning equipment and will be pleased to make recommendations.

472. Bulletin describes stabilizing lime-softened water by recarbonation, discussing gas production, washing, compressing, drying, and applying the CO(2). Infilco, Inc., 325 West 25th Place, Chicago, Ill.

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500. Data on anti-freeze outdoor drinking fountains, hydrants, street washers, etc., will be sent promptly on request to Murdock Mfg. & Supply Co., 426 Plum St., Cincinnati, Ohio.

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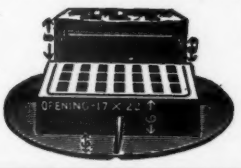

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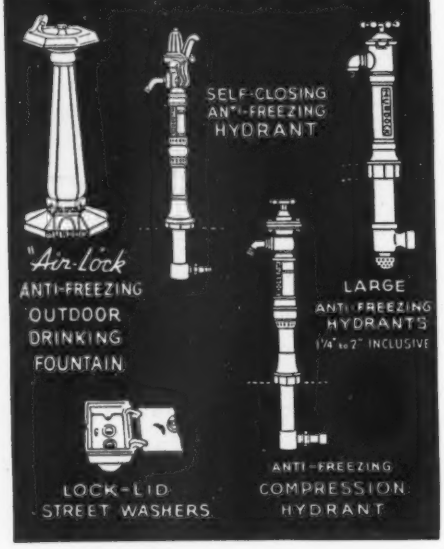
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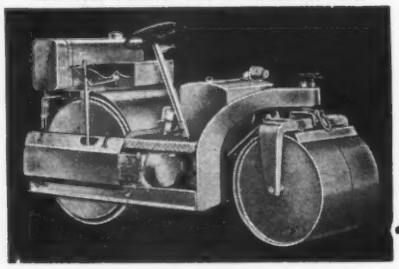

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To: Manufacturers of Construction Materials, Plumbing, Heating and Electrical Specialties.

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Harold J. Flannery, San Jose, Calif.
Erb Hanson (Acting), Connersville, Ind.
Harold E. Beine, Gary, Ind.
William C. Goyne, Jeffersonville, Ind.
Sam Leslie, St. Joseph, Mo.
Frank Sepede, Little Ferry (P. O. Lodi), N. J.
Walter Scholla (Acting), Montclair, N. J.
Joseph E. English, Trenton, N. J.
Raymond W. Murphy, Rye, N. Y.
A. B. Demo (Acting), Jamestown, N. D.
A. R. Onken, Alice, Tex.

City Managers

D. McLeod, Stratford, Conn.
Frank W. Voisine, Manistique, Mich.
R. W. Flack, Charlotte, N. C.

Water Works Superintendents

Brayton S. Norton, Laguna Beach, Calif.
Charles Hebior, North Chicago, Ill.
W. Allen, Alexandria, La.
Claude L. Mosher, Marquette, Mich.
James S. Coon, Beatrice, Nebr.
Frank Cherry, Saratoga Springs, N. Y.
Monte Beck, Lexington, N. C.
L. S. Jordan, Oregon City, Ore.

County Engineers

John S. Scott, Bent Co., Caddoa, Colo.
Kellie Adams, Morgan Co., Fort Morgan, Colo.
Donald O. Baker, Randolph Co., Chester, Ind.
Ray Fisher, Marion Co., Indianapolis, Ind.
M. R. Nicol, Wyandotte Co., Kansas City, Kan.
J. T. Bullen, East Baton Rouge Parish, Baton Rouge, La.
Joseph D. Baker, Washington Co., Hagerstown, Md.
G. Frank Wetzel, Cumberland Co., Carlisle, Pa.
Don Slawson, Codington Co., Watertown, S. D.

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